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A DOCUMENTATION
OF THE
AQUATIC ENVIRONMENT AND FISHERIES
IN THE
UPPER BLACKFOOT RIVER DRAINAGE
TO
DETERMINE EFFECTS OF OPEN PIT MINING FOR PHOSPHATE

(Angus, Kendall and Mill Creeks and the Blackfoot River)

Caribou National Forest, Idaho

January 1976

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Biological Aide



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INTRODUCTION

Open pit mining for phosphate ores in the Angus Creek drainage, prior to 1970, caused sediment and petroleum pollutants to enter Angus Creek (Platts 1970). Stream channels in headwater areas were covered with fine sediment, and petroleum products were observed throughout the upper system. Since this pollution release the mining corporation has made good progress in containing potential pollutants and preventing off-site movement. However, the possibility exists that the present open pit mining in conjunction with future mining will provide additional environmental stress in not only Angus Creek but the Blackfoot River. The accelerating of phosphate mining throughout southeastern Idaho will significantly increase sediment delivery to the streams and increased sediment transport and containment throughout most of the

Blackfoot system (Kelly 1975). Basic data is not available to allow the landmanager to predict these accelerated sediment effects on the fisheries resources, nor is information available to evaluate the effects other pollutants may have. For the landmanager to be able to function in this predictive position requires the fulfilling of five requirements:

1. Document all aquatic environments and fish populations within the phosphate mineral areas that have been or may be influenced by mining or related activities.
2. Determine natural fluctuations in the state variables describing aquatic environment and fish populations.
3. Determine the stress applied to aquatic ecosystems from past, present and future mining.
4. Determine the effects of this stress on the aquatic life.
5. Determine potential future stress to aquatic resources from proposed mining and related activities by relating to past and present experience and recommend ways to buffer this stress.

To initiate the fulfillment of these requirements, conditions in the aquatic environment and fish populations in selected stream areas under, or with potential to be under, future mining influences were documented and monitored. These selected areas included Angus Creek, the Blackfoot River above and below the Angus Creek influence area, Kendall Creek, and Mill Creek (Platts 1970, 1970a, 1973, 1973a). Information from these Progress Reports is meshed with additional information to better document the aquatic environmental conditions and determine the environmental state. This documentation will assist future studies to determine changes that may take place in the aquatic life and the stress or condition that caused it. The impacts of past, present, and future land

use activities can then be evaluated. This information combined with a monitoring program will allow the landmanager to make early determinations if any environmental stress occurs on these aquatic systems from land use activities and allow predictions to be made of aquatic environmental reaction to proposed mining plans.

STUDY AREA DESCRIPTION

The study area is confined mainly to tributaries in the headwater section of the Blackfoot River (Figure 1), which begins at the confluence of Lanes and Diamond Creeks (T.7S, R.44E., S.10). The main study tributary, Angus Creek, is within a 1.5 mile radius of the Blackfoot River's inception. Kendall Creek is a tributary of Diamond Creek, entering 4 miles upstream from its mouth. Mill Creek (Sections 13 and 18) is a tributary of the Blackfoot River and is within a radius of 3 miles from the Blackfoot River's inception. Mill Creek heads adjacent to the headwaters of Angus Creek on the opposite side of the Wooley Range.

Angus Creek drains 13.9 square miles and has an average annual maximum discharge of 174 cfs (U.S. Geological Survey, 1965). The mean average annual precipitation is 20 to 30 inches with a mean annual runoff of 10 inches (Pacific Northwest River Basins Commission, 1970). The strata of the upper Blackfoot basin including the Angus Creek drainage are comprised partly of the Permian Phosphoria formation and larger areas of Triassic sedimentary rocks (Shaw and Newell, 1974). The ore body contains about 25 percent phosphorus pentoxide (P_2O_5).

The Blackfoot River enters the Snake River 8 miles southwest of Blackfoot, Idaho, drains 1,295 square miles (581 square miles are below the Blackfoot reservoir), and has a mean average flow of 154 cfs (Idaho Water Resource Board, 1972). The river meanders 35 miles from an elevation of 6,420 feet at its initiation to 6,118 feet where it empties into the Blackfoot Reservoir. This irrigation reservoir has a capacity of 413,000 acre-feet and a surface area of 17,300 acres (Pacific Northwest River Basins Commission, 1970). Seventy-eight miles below this reservoir the Blackfoot River enters the Snake River at an elevation of 4,400 feet.

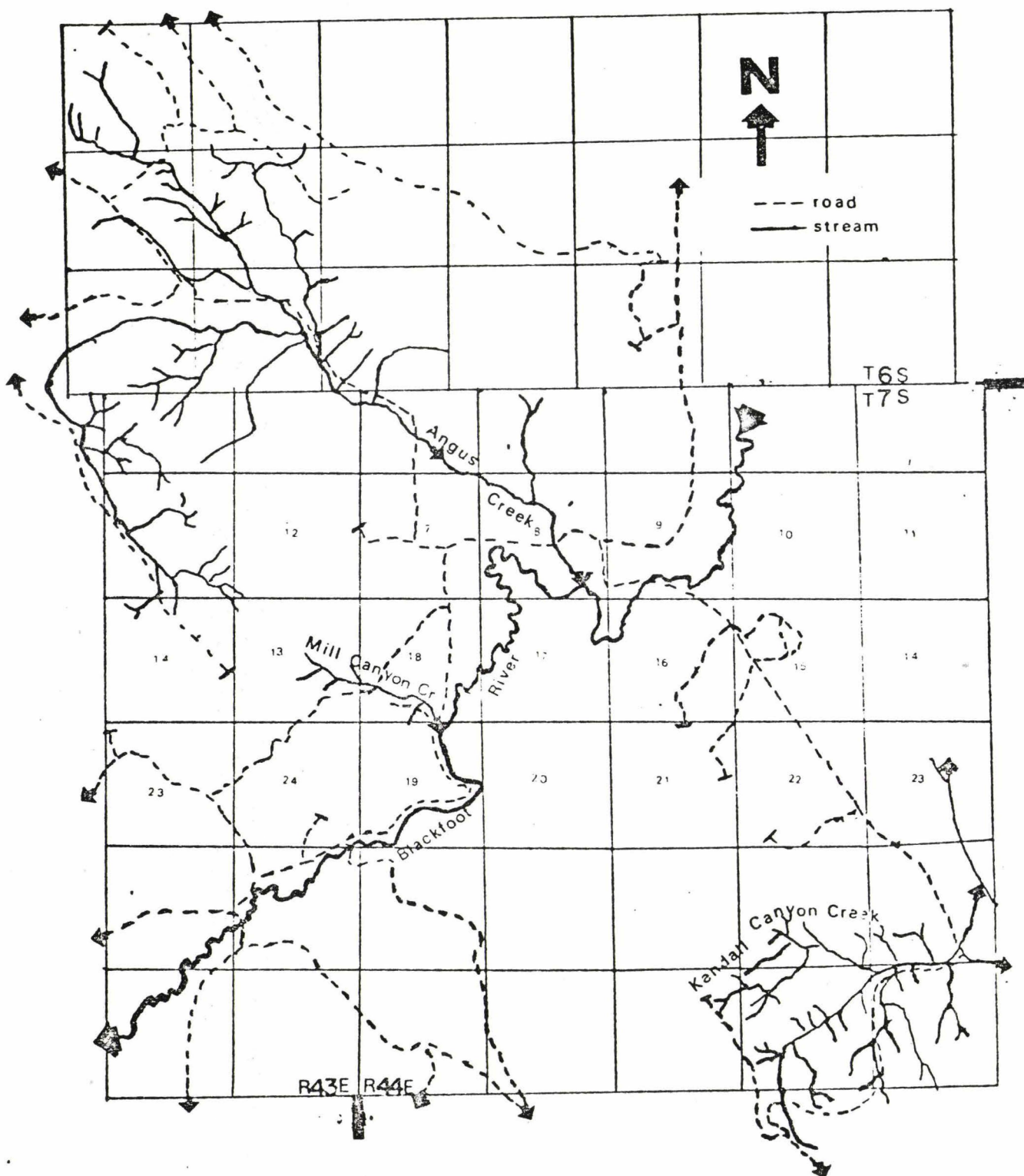


Figure 1. Upper Blackfoot River Study Area

PROBLEM

The present main mining disturbance within this study area having potential to exert stress on the aquatic environment occurs in the headwaters of the Angus and Mill Canyon Creek drainages (T.7S) (Figure 2). Because of the ore location and mining methods used, it is necessary to disrupt headwater lands and ephemeral streams to mine and store ore and non-ore (waste) materials. The proposed disturbance of 60 additional acres of land on the westside of Angus Creek (Stauffer Mining Company plan) will create additional potential pollution sources. Forest Service engineers, soil scientists and hydrologists determined that disturbance in the original mining plan would result in the delivery of 9.8 acre-feet of accelerated sediment to Angus Creek. This sediment increase is about 130 times the natural Angus Creek sediment rate and could eliminate most of the game fish populations.

Forest Service scientists and Stauffer Mining Company personnel have proposed additional operational safeguards and rehabilitation measures to alleviate the pollutants Angus Creek could receive from this phase of the mining operation. The mining plan is being modified and should provide additional operational and rehabilitation safeguards to reduce the volume and types of sediment leaving the disturbed area. The management goal is to develop an acceptable land use plan based on viable data that will allow the removal of the required phosphate ore while minimizing the environmental stress the mining will place on the Angus Creek aquatic environment. Mill Creek, Kendall Creek, and the Blackfoot River, along with other aquatic systems in southeastern Idaho,

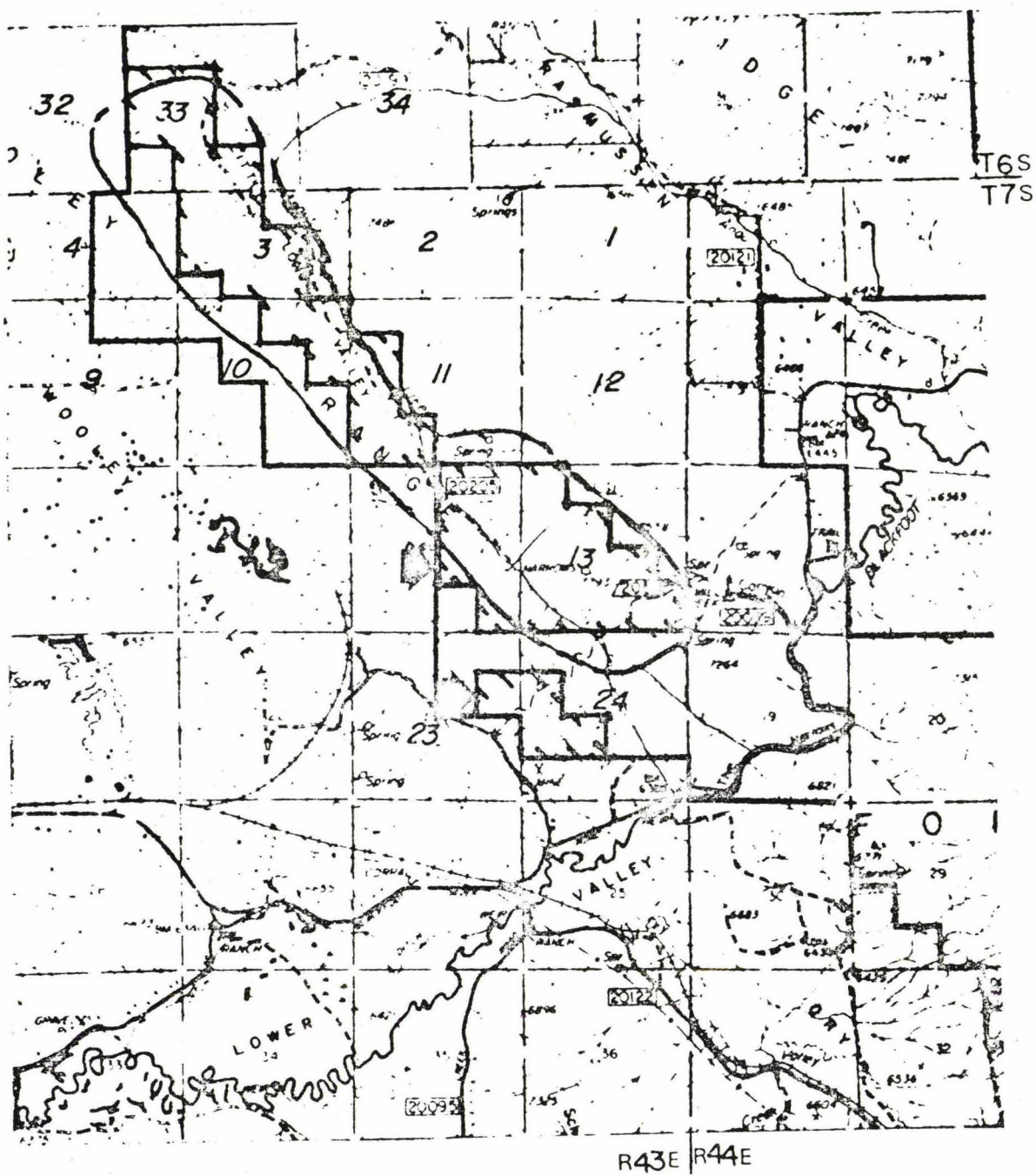


Figure 2. Lease boundary (TTTT) of Wooley Valley Mine of the Stauffer Chemical Co., indicated by arrows.

also face a potential degradation from mining activities. This study was designed to provide the information required to identify problems that exist or that may occur and the information needed to monitor the future mining projects. With sufficient data available for constant evaluation, mining of the phosphate ore can be made more compatible with the aquatic resources.

AQUATIC STRUCTURE AND STREAMSIDE ENVIRONMENT

Angus Creek

Angus Creek is a small, low gradient stream with low stream power, and excellent pool structure. About 87 percent of the stream is in pools. The water flow, depth and streambottom composition has been modified and is now partly controlled by beaver activity. The stream width averages about 8 feet with 10 inches of depth. The stream channel surface in 1970 averaged 63 percent fine sediment, 24 percent gravel, 7 percent rubble and 6 percent boulder. The channel surface materials composition has not changed significantly in four years (Table 1). Although in most streams the gravel and rubble substrate provides the habitat essential for fish food production, in Angus Creek these materials are quite limited in certain reaches. The sand-silt substrate dominating the stream channel bottom (especially in beaver dams) plays an influential role in food production in this system, because of low stream power.

Streambank cover, condition, and habitat type rate only fair to good, partly because the lower reaches of Angus Creek are receiving stress on the streamside environment from livestock use, although Angus Creek still has a productive streamside environment. Streamside conditions in 1970 were very close to streamside conditions in 1974.

Except for Station 9, which is being directly influenced by mining, the aquatic structural condition, except pool rating, in 1970 was almost identical to 1974. The aquatic environment is stable. The temporal difference in pool rating is due to a 1974 change in the rating system (Table 27). This methodology problem will be identified and corrected with the continuation of the study and monitoring program.

Table 1. A comparison of Angus Creek aquatic environmental conditions on August 21, 1970 with August 19, 1974

Year	Station	Width (ft)	Depth (in)	Riffle	Pool		Streamchannel			Fine Sediment	Streambank	
				Width (ft)	Width (ft)	Rating	Boulder	Rubble (Percent)	Gravel		Cover	Condition (Rating)
1970	1	5	4	2	3	1	55	7	26	12	2.0	3.4
1974	1	7	6	2	5	4	38	13	42	7	2.0	3.0
1970	2	9	7	4	5	2	0	0	45	55	1.6	1.2
1974	2	7	6	3	4	4	0	4	61	35	1.6	2.6
1970	3	13	16	0	13	1	0	0	0	100	3.0	3.8
1974	3	10	12	1	9	5	0	0	17	83	3.4	3.6
1970	4	8	8	0	8	3	0	21	64	15	1.8	2.8
1974	4	8	13	0	8	5	0	23	40	37	2.0	3.6
1970	5	5	4	2	3	4	0	36	24	40	2.0	1.8
1974	5	4	7	1	3	4	0	0	7	93	2.0	4.0
1970	6	12	15	0	12	1	0	0	3	97	3.0	4.0
1974	6	9	20	0	9	5	0	0	0	100	2.0	4.0
1970	7	4	5	1	3	3	0	0	43	57	2.0	1.4
1974	7	5	6	2	3	4	0	10	38	52	2.0	3.8
1970	8	5	14	0	5	1	0	0	8	92	2.4	4.0
1974	8	9	6	0	9	4	0	0	17	83	2.0	3.0
1970	9	23	13	0	23	1	0	0	3	97	2.2	3.8
1974	9	--	--	-	Creek was almost dry because of mining activities							
1970 Average		9	10	1	8	2	6	7	24	63	2.2	3.0
1974 Average		7	10	1	6	4	5	6	28	61	2.1	3.5

Additional documentation and monitoring stations were established in 1973 on Angus Creek to allow more intensive documentation of a selected stream section that is more closely related to mining activity. These isolated monitoring stations do not attempt to describe the complete system, but provide a method to demonstrate and quantify any alterations of a selected aquatic state that may occur. Changes in state could then be identified by types, and magnitude of the stress applied could then be measured.

The Angus Creek Narrows station encompasses a channel reach that has a higher stream gradient than most channel areas on Angus Creek and with less beaver dam influence. However, in 1974, beaver dam influence increased in the upper 15 transects (Table 2). In 1973 transects 1 through 15 could be surveyed in hip boots, but in 1974 waders had to be used because of the increased water depth. The transects were not permanently marked until 1974, so the 1973 data and the 1974 data cannot be compared by transect, but only by combinations of transects.

From 1973 to 1974 between transects 6 and 35 in the Angus Creek Narrows, there was a shift from gravel to rubble, with gravel decreasing by 20 percent and the rubble increasing by a factor of 2. This change may be due to transects not being staked until 1974. Now that transects have been permanently marked, additional study will quantify and verify temporal aquatic conditions. The other aquatic structural measurements show that the Angus Creek Narrows had little change from 1973 to 1974.

Table 2. A comparison of conditions in the Angus Creek Narrows Station August 1973 with conditions August 1974.

Transects	Stream		Riffle/Pool (Ratio)	Riffle Width (ft)	Pool		Stream Channel				Cover	Streambanks	
	Width (ft)	Depth (in)			Width (ft)	Rating	Boulder	Rubble (Percent)	Gravel	Fine		Condition (Rating)	Type
1973	1-5	4	4	1.0	2	2	10	5	60	25	2	3	5
	6-10	5	3	0.7	2	3	4	7	59	30	3	4	4
	11-15	4	4	-	-	4	0	0	100	0	2	4	5
	16-20	5	5	0.7	2	3	0	0	77	23	2	4	5
	21-25	5	4	0.2	1	4	0	0	62	38	3	4	5
	26-30	4	5	0.3	2	3	0	0	59	41	2	4	5
	31-35	5	4	0.2	1	4	0	44	24	32	2	4	5
	36-40	5	5	0.7	2	3	0	4	70	26	2	3	5
	41-45	5	5	0.2	1	4	0	8	50	42	3	4	5
	46-47	6	7	0.5	2	4	0	25	8	67	3	3	4
Average	5	4	0.2	2	3	2	1	9	50	40	2	4	5
1974	1-5	9	21*	0.5	3	6	0	7	5	88	3	4	-
	6-10	10	25*	0.0	0	10	0	21	8	71	3	4	-
	11-15	9	20*	0.0	0	9	7	23	7	63	2	4	-
	16-20	6	6	0.5	2	4	4	27	34	35	3	3	-
	21-25	4	5	1.0	2	2	5	0	67	28	2	3	-
	26-30	4	6	1.0	2	2	0	29	29	42	2	3	-
	31-35	5	5	1.5	3	2	0	100	0	0	3	4	-
	36-40	6	8	0.2	1	5	4	4	49	43	2	3	-
	41-45	5	6	0.7	2	3	0	10	38	52	2	3	-
	46-50	5	4	4.0	4	1	3	23	54	20	3	3	-
Average	6	11	0.5	2	4	4	2	24	30	44	3	3	-

*New beaver activity

An impoundment for both debris confinement and water storage has been constructed in upper Angus Creek and functions similarly to a large beaver dam. The reservoir immediately provided the habitat for production of a large standing crop of fresh water shrimp. Stocked cutthroat trout (Henrys Lake variety) feeding on this abundant shrimp population and other invertebrates attained rapid growth. If the withdrawal of water by the mining company for road surface sprinkling continues to be compatible with fishery needs, and if the storage area does not fill with sediment, the basin will continue to provide an excellent cutthroat trout fishery.

Kendall Creek

Kendall Canyon Creek is a perennial stream with a precipitous channel within the Forest Service boundary. This drainage extends over a maximum linear distance of only 2.75 miles and has an average gradient of 6 percent. The stream structure for fisheries has been characterized as poor within the Forest Service boundary (Platts, 1975). Although this stream provides a minor spawning environment for cutthroat trout from the Blackfoot River system, the high channel gradient and poor quality pools result in a low fish standing crop.

Mining and livestock grazing activities have occurred within the environs of Kendall Creek, but the effects of these activities are insignificant, and logging has not been undertaken in this drainage (Platts, 1975).

Mill Creek

Mill Creek (T.7S, R.44E, S.18), a drainage of the Wooley Range should be distinguished from Mill Creek (S.15, 21 and 28) of the same township and range), a drainage of Dry Ridge which is not included in this study section but appears later under chemical conditions. Mill Creek, is a perennial stream that drains the southern end of the Wooley Range and empties directly into the Blackfoot River. This relationship with the Blackfoot River encompasses its total significance, since the 1.2 mile stream length and the precipitious average channel gradient of 12 percent create little, if any, fishery value. The average stream flow (3.34 cfs) is sufficient to sustain a small trout fishery in the lower reach.

No logging has occurred, but both mining and livestock grazing have caused moderate alterations in the aquatic environment. If the mining is continued, as planned, more severe alterations may be expected, such as increases in erosion, turbidity and sedimentation (Platts, 1975). The large waste dump in the headwaters poses a continual potential pollution source to this stream and in turn the Blackfoot system. In the past, this stream has been observed to run very turbid, because of sediment eroding from the mine waste dump. Efforts are presently underway to relinquish the special use permit at the head of Mill Creek to eliminate additional storage of waste materials.

Blackfoot River

The upper Blackfoot River from its inception at the confluence of Lanes and Diamond Creeks to the Blackfoot Reservoir maintains a perennial flow over its 35 mile length. The average flow is 262 cfs just below the Forest Service boundary (Kelly, 1975). The meandering channel is wide and shallow, with an extremely low gradient of about 0.1 percent. The channel is contained by low banks formed from fragile depositional materials. Streamside vegetation is composed mainly of grass with some willow and sagebrush. This stream continually carries excellent fish populations, even though it is subjected to a high fishing pressure (Platts, 1975).

From two Blackfoot River monitoring stations, initiating at the mouth of Blackbird Creek, one being upstream and one downstream, a comparison of aquatic environmental conditions between 1973 and 1974 showed that the two stream sections were stable and quite similar (Table 3).

The monitoring transects were used for aquatic variable recording in 1973 and 1974, but the transects were not permanently marked until 1974. Thus, it will take two more years to completely document these stations. The only noticeable structural difference was in 1974. The upstream station above the Angus Creek confluence had an increase in fine sediment, especially in the channel area between transects 16 and 20. Now that the transects have been permanently marked, the reading of future years will determine if this is a change in the bottom composition. The stream was wider and deeper in 1974 than in 1973. Pool and riffle changed considerably but this is due to methodology. The bulk of the river is neither pool nor riffle but certain types of runs. In the future, the stream needs to be classified by pool, riffle, shallow run and deep run to eliminate this confusion. Channel materials and the streambank environment had little

Table 3. A comparison of the Blackfoot River's aquatic environmental conditions in August 1973 with August 1974

Transects	Width (ft)	Depth (in)	Riffle/Pool	Riffle	Pool		Stream Channel				Streambanks			
			(Ratio)	Width (ft)	Width	Rating	Boulder	Rubble	Gravel	Fine Sediment	Cover	Condition (Rating)	Type	
Upstream from Angus Creek														
1973	1-5	38	16	-	-	38	2	8	20	40	32	2	2	4
	6-10	38	17	-	-	38	2	9	0	55	36	2	2	4
	11-15	37	17	0.3	8	29	2	12	9	55	24	2	3	5
	16-20	42	11	7.4	37	5	4	0	0	96	4	2	2	4
	21-25	41	9	9.2	37	4	5	5	20	59	16	2	3	5
Average		39	14	-	-	23	2	7	10	61	22	2	2	4
1974	1-5	45	28	.9	21	24	4	2	14	35	49	2	2	-
	6-10	45	24	2.8	33	12	4	0	0	50	50	2	3	-
	11-15	37	32	.1	4	33	5	12	19	49	20	2	3	-
	16-20	46	20	2.5	33	13	4	0	2	72	26	2	2	-
	21-25	47	17	3.3	36	11	4	1	10	71	18	2	2	-
Average		44.0	24	1.3	25	19	4	3	9	55	33	2	2	-
Downstream from Angus Creek														
1973	1-5	41	31	.3	9	32	3	9	30	42	19	2	2	4
	6-10	36	11	1.6	22	14	4	8	47	26	19	2	2	5
	11-15	48	8	8.6	43	5	5	8	8	73	11	2	2	4
	16-20	44	13	0.4	13	31	2	7	6	54	33	2	2	4
	21-25	39	15	0.2	5	34	2	4	7	45	44	2	3	5
Average		42	12	2.2	18	24	3	7	20	48	25	2	2	4
1974	1-5	45	19	1.8	29	16	4	10	23	47	20	2	3	-
	6-10	42	15	5.0	35	7	3	6	63	22	9	2	3	-
	11-15	58	15	3.8	46	12	2	6	16	57	21	2	3	-
	16-20	49	20	2.8	36	13	2	2	1	62	35	2	2	-
	21-25	45	23	1.7	28	17	3	8	42	30	20	2	3	-
Average		48	18	2.7	35	13	3	6	29	44	21	2	3	-

change.

The influence of previous mining and logging activities is negligible, but moderate stress on the environment has resulted from livestock grazing. The continuation of proposed mining however, could have moderate detrimental effects upon one of the most valuable fishery streams in Southeastern Idaho (Platts, 1975).

HYDROCHEMISTRY AND HYDROPHYSICS

Angus Creek

Subsurface water continuously enters Angus Creek, and during major storms and snowmelt the stream also receives surface runoff. The nitrates in Angus Creek, while below the point of excess eutrophication, exceed the levels in Kendall Creek and could increase the load of nitrates in the Blackfoot River (Figure 3 and Table 4). In concurrence with the high phosphate concentration, the nitrogen-phosphate ratio on Angus being only 1.5, the total inorganic phosphates are at a level that would tend to promote the flourishing of algae and other aquatic flora.

The average alkalinity of 138 ppm, hardness of 101 ppm and pH of 7.7 units are ideal for a salmonid fishery and contribute to the fertility and biotic productive potential of Angus Creek. Mercury, lead, copper, selenium and fluoride are low or negligible in solution, although manganese and chloride ions are high in concentration but below critical levels (Tables 5, 6 and 7). Iron at certain stations at certain periods is excessive in Angus Creek and in all streams of the study area (Table 6). However, these amounts are not causing any identified problems in any of the systems.

The average chemical oxygen demand (COD) in Angus Creek is 8.5, as compared with the average of 6.3 in the Blackfoot River. A test of an hypothesis on these means demonstrated that the difference is significant at the 99.5% level. The 99.5% confidence interval of 8.5-6.3

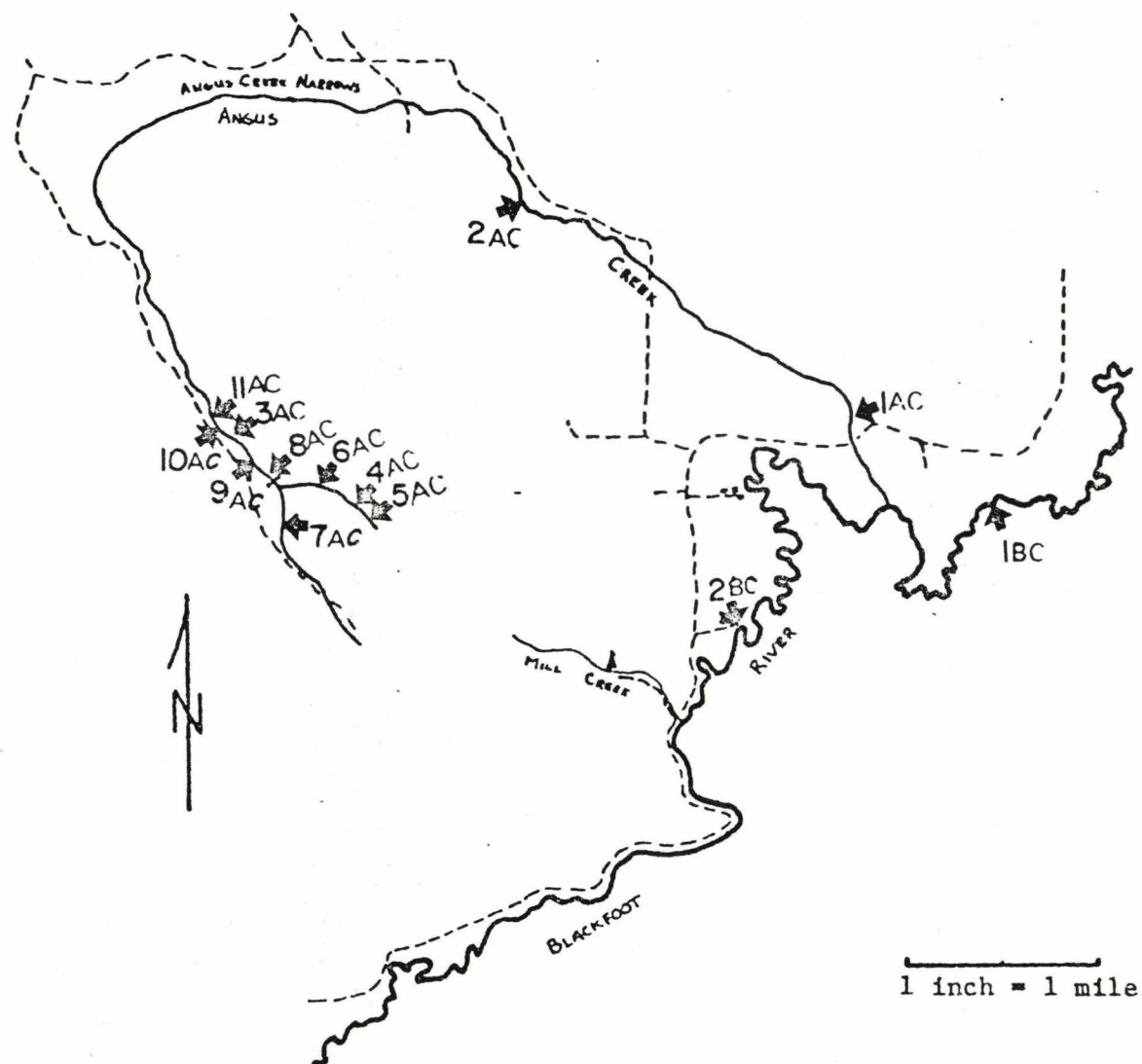


Figure 3. Location of hydrochemical and hydrophysical sampling sites.

Table 4. Mean values of hydrochemical parameters from 1970 to 1974 inclusive (ppm). The number of samples analyzed is in parenthesis.

Stream	Metals and Metallic Activities							Hardness (CaCO ₃)
	Cu	Fe	Hg	Mn	Na	Pb	Se	
Angus Creek	.001(10)	.13(80)	.0003(4)	.06(8)	4.4(33)	.01(8)	Neg(4)	101(65)
Blackfoot River								
Above Angus	.002(2)	.16(15)	.0003(1)	.01(1)	4.2(4)	.01(2)	N.A.*	109(11)
Below Angus	.002(2)	.10(15)	.0013(1)	.01(1)	4.8(4)	.01(2)	N.A.	115(11)
Kendall Creek	N.A.*	.14(6)	N.A.	N.A.	N.A.	N.A.	N.A.	89(5)
Mill Creek	N.A.*	.14(8)	N.A.	N.A.	N.A.	N.A.	N.A.	119(7)

*N.A. - Not Available

(Continued)

Table 4. (Continued)

Stream	Nonmetals							D.O.
	C (to)	Cl	F	N (t)	NH ₃	NO ₃	NO ₂	
Angus Creek	2.1(17)	9(6)	.01(4)	3.4(68)	.02(17)	.25(17)	.004(17)	12(9)
Blackfoot River								
Above Angus	1.5(4)	2(1)	N.A.*	2.5(11)	.02(4)	.01(4)	.001(4)	14(2)
Below Angus	1.5(4)	1(1)	N.A.*	2.5(11)	.01(4)	.17(4)	.001(4)	14(2)
Kendall Creek	0.9(6)	N.A.*	N.A.	N.A.	.01(6)	.21(6)	.002(6)	13(4)
Mill Creek	1.9(8)	N.A.*	N.A.	N.A.	.01(8)	.28(8)	.001(8)	12(4)

*N.A. - Not Available

(Continued)

Table 4. (Continued)

Stream	Nonmetals and Nonmetallic Activities						pH
	P (t)	PO ₄	PO ₄ (ti)	SO ₄	Alkal (CaCO ₃)	COD	
Angus Creek	.34(83)	.09(25)	.24(17)	8(25)	138(51)	8.5(17)	7.6(17)
Blackfoot River							
Above Angus	.24(14)	.08(5)	.26(4)	9(6)	131(9)	6.5(4)	7.8(4)
Below Angus	.25(14)	.03(5)	.14(4)	9(6)	131(9)	6.1(4)	7.8(4)
Kendall Creek	.04(6)	.02(6)	.05(6)	10(6)	88(6)	3.7(6)	7.5(6)
Mill Creek	.07(8)	.03(8)	.13(8)	10(8)	105(8)	11.1(8)	8.1(8)

Table 5. Mean values of hydrophysical parameters for period 1970 to 1974 inclusive. Number of samples is in parenthesis.

Stream	TS (ppm)	TDS (ppm)	Turbidity (JTU)	Temperature Degrees F
Angus Creek	243(87)	214(56)	24(73)	40(11)
Blackfoot River				
Above Angus	248(11)	201(9)	33(15)	42(2)
Below Angus	248(11)	200(9)	29(15)	39(1)
Kendall Creek	195(6)	N.A.*	35(6)	N.A.
Mill Creek	230(8)	N.A.*	39(8)	N.A.

*N.A. - Not Available

Table 6. Hydrochemical data for Angus Creek and Blackfoot River for years 1970-1973 (ppm)

Date	Station	Total g	Total F	TS	TDS	Fe	Alka.	Hard.	Na	NO ₃ WT%	Mn	Cl	F	Cu	Se	PO ₄	SO ₄	Pb	Hg	Temp.
6/11/70	1AC	3.4	.650	272	227	<.01	144	80	3.3											
	2AC	4.4	.636	272	234	<.01	140	84	3.1											
6/22/70	1AC	4.0	.672	277	250	<.01	164	80	3.4											
	2AC	4.8	.616	276	240	<.01	160	84	3.3											
	3AC	4.4	.609	268	246	<.01	160	72	3.0											
	4AC	5.6	.629	288	270	<.01	176	104	3.4											
7/6/70	1AC	3.2	.643	268	238	<.01	136	76	2.9											
	2AC	4.4	.650	264	227	<.01	144	64	3.3											
	3AC	3.6	.650	260	202	<.01	128	76	3.3											
	4AC	4.4	.657	268	222	<.01	128	56	1.9											
7/20/70	1AC	3.2	.650	260	204	.07	136	72	2.9											
	2AC	4.2	.672	260	220	<.01	144	64	2.1											
	3AC	3.8	.657	264	200	.03	124	68	2.3											
	4AC	4.0	.650	272	212	<.01	140	72	3.2											
8/5/70	1AC	4.0	.657	284	250	<.01	164	84	3.7											
	2AC	5.2	.636	268	227	.01	136	64	3.6											
	3AC	4.4	.670	280	242	.01	148	72	3.3											
	4AC	4.4	.672	282	270	<.01	192	88	3.4											
	1BC	4.4	.675	288	260	<.01	172	84	2.8											
	2BC	4.8	.629	272	260	<.01	172	92	3.1											
8/28/70	1AC	3.6	.657	288	260	<.01	164	80	4.0											
	2AC	5.0	.629	292	270	<.01	180	92	4.0											
	3AC	4.2	.657	296	270	<.01	184	92	3.6											
	4AC	4.4	.657	304	280	<.01	184	96	3.5											
	1BC	4.8	.622	280	260	<.01	176	96	3.0											
	2BC	5.2	.643	284	250	<.01	152	76	3.0											
9/9/70	1AC	3.4	.664	284	260	.02	164	80	3.7											
	2AC	5.2	.657	298	260	<.01	180	90	3.6											
	3AC	4.0	.671	276	246	<.01	140	64	3.4											
	4AC	4.8	.644	296	270	<.01	172	80	3.3											
	1BC	4.0	.676	282	260	<.01	158	80	3.0											
	2BC	4.4	.683	284	270	<.01	184	84	3.0											
9/22/70	1AC	13.6	<.1	272	228	.26		4			.04	13	<.01	<.001	Neg	.27				45
	2AC	7.2	<.1	288	246	.12		4			.07	10	<.01	<.001	Neg	.21				46
	3AC	17.0	<.1	264	228	.18		4			<.01	13	<.01	<.001	Neg	.19				41
	4AC	9.6	<.1	296	260	.13		4			.10	13	<.01	<.001	Neg	.19				40
10/5/70	1AC	.6	.278	288	241	<.01		148												
	2AC	.8	.188	252	198	.05		164												
	3AC	.8	.260	280	230	.06		172												
	4AC	.6	.263	282	246	.05		172												
	1BC	.6	.213	280	235	.09		176												
	2BC	.8	.188	272	210	.05		172												
10/20/70	1AC	7.0	.26	272	228	.03		<.001								<.01	<.0002			43
	2AC	5.0	.35	284	244	.07		<.001								<.01	<.0002			43
	3AC	3.2	.35	260	196	.10		<.001								<.01	.0007			40
	4AC	4.4	.13	224	164	<.01		<.001								<.01	.0002			39
	1BC	7.0	.47	324	176	.04		<.001								<.01	.0032			45
	2BC	6.8	.44	272	208	.04		<.001								<.01	.0013			
11/5/70	1AC	.4	.222	264	230	.14	120	208								3				33
	2AC	.4	.127	236	218	.09	116	172								3				34
	3AC	.4	.120	240	214	.17	128	180								3				36
	4AC	.4	.204	248	212	.11	144	200								3				39
	1BC	.4	.104	240	218	<.01	140	180								4				39
	2BC	.4	.127	232	234	.04	144	176								3				39
4/20/71	1AC	1.0	.025	156	120	.04														
	2AC	1.1	.025	124	82	.13														
	3AC	1.0	.013	136	102	.12														
	4AC	.9	.060	176	146	.06														
	1BC	.8	.018	112	112	.15														
	2BC	.8	.058	152	112	.01														
5/5/71	3AC	1.6	.245	176	125	.33														
	4AC	1.4	.019	196	152	.15														
5/20/71	1AC	1.7	.043	132	100	.27														
	2AC	1.4	.028	160	121	.07														
	3AC	.8	.034	196	154	.34														
	4AC	1.1	.060	192	143	.26														
	1BC	.9	.025	156	122	.19														
	2BC	.8	.095	200	148	.10														
6/4/71	AC	1.3	.052	157	148	.27														
	2AC	1.2	.024	144	110	.16														
	3AC	1.0	.010	172	140	.13														
	4AC	1.4	.074	220	175	.13														
	1BC	1.0	.030	154	130	.14														
	2BC	1.3	.112	196	150	.16														
5/16/72	1AC	.8	.143	196		.34		64							4.002					
	1BC	1.6	.104	232		.44		108							4.002					
	2BC	1.6	.108	244		.28		110							4.002					
	3AC	2.0	.301	340		1.82		104							4.004					
	4AC	2.0	.098	304		.15		106							4.002					
	5AC	1.6	.091	284				140												
	6AC	6.4	2.468	336				80												
	7AC	4.8	.864	288				48												
	8AC	5.2	.717	232				48												
	9AC	3.2	.293	132				48												
	11AC	-	.068	240				104												
	17AC	-	.248	178				36												
7/30/73	1AC	2.9		248		.26	144	132	18	<.001	.10	1	<.001		.15	5	<.01			
	2AC	2.1		216		.23	148	132	14	<.001	.14	1	<.001		.01	6	<.01			
	3AC	2.2		292		.04	136	140	13	<.001	.01	1	<.001		.16	8	<.01			
	4AC	2.5		268		.18	140	140	10	<.001	.07	2	<.001		<.01	9	<.04			
	1BC	2.3		256		.05	124	114	8	<.001	.01	2	<.001		<.01	10	<.01			
	2BC	2.0		240		.12	124	140	10	<.001	.01	1	<.001		.02	11	<.01			

Table 7 Hydrochemical data for Angus Creek, Kendall Creek, Mill Creek and the Blackfoot River for 1974 (ppm)

Stream	Station	Date	COD	pH	Alkal (CaCO ₃)	Hard (CaCO ₃)	NH ₃	NO ₃	NO ₂	PO ₄	PO ₄ (Ti)	P (T)	C (TO)	SO ₄	Fe
Angus Cr.	1 AC	7/9	8.8	7.5	116	116	.01	1.50	0.42	.03	.03	.05	1.5	10	.25
	1 AC	8/16	10.8	8.0	220	100	.03	.01	.001	.05	.13	.09	2.5	10	.65
	1 AC	9/16	10.0	7.3	132	132	.01	.02	.001	.04	.12	.09	1.7	10	.02
	1 AC	10/17	6.0	7.2	120	124	.01	.06	.001	.03	.12	.07	1.2	10	.01
	Av.		8.9	7.5	147	118	.02	.40	.011	.04	.10	.08	1.7	10	.23
Angus Cr.	2 AC	7/9	10.8	7.5	116	100	.01	1.29	.002	.07	.19	.10	2.4	10	.10
	2 AC	8/15	7.6	7.3	120	124	.03	.01	.001	.43	1.55	.50	2.8	10	.55
	2 AC	9/16	7.6	7.6	96	112	.01	.01	.001	.05	.17	.06	1.6	10	.03
	2 AC	10/17	6.4	7.7	92	100	.01	.09	.001	.04	.14	.07	1.2	10	.01
	Av.		8.1	7.5	106	109	.02	.35	.001	.15	.51	.18	2.0	10	.17
Angus Cr.	3 AC	7/9	7.2	7.9	88	120	.01	.51	.001	.06	.10	.05	1.3	10	.21
	3 AC	7/10	5.6	7.8	44	92	.01	.09	.001	.02	.10	.04	.8	10	.01
	3 AC	8/15	7.2	7.7	100	104	.01	.01	.001	.03	.13	.06	1.6	10	.78
	3 AC	9/16	7.2	8.2	116	76	.01	.13	.001	.01	.12	.06	1.8	10	.01
	Av.		6.8	7.7	87	98	.01	.19	.001	.03	.11	.05	1.4	10	.25
Angus Cr.	4 AC	8/16	10.4	8.1	88	88	.01	.01	.001	.06	.30	.13	3.5	10	.01
	4 AC	9/17	8.4	8.0	84	92	.01	.01	.001	.04	.22	.08	3.2	10	.01
	4 AC	10/17	9.2	7.5	88	100	.03	.42	.004	.10	.35	.13	3.2	10	.25
	4 AC	10/18	10.0	7.5	108	112	.01	.01	.001	.05	.21	.09	2.9	10	.03
	Av.		9.5	7.8	92	98	.02	.11	.002	.06	.27	.11	3.2	10	.08
Angus Cr.	8 AC	7/9	10.8	7.9	100	100	.06	.57	.001	.05	.10	.06	3.3	10	.11
Blackfoot Riv.	1 BC	7/10	5.6	7.5	104	112	.01	.01	.001	.05	.16	.10	1.5	10	.24
	1 BC	8/16	7.2	8.3	84	88	.01	.01	.001	.05	.21	.09	1.7	10	.10
	1 BC	9/17	8.4	8.1	100	96	.04	.01	.001	.27	.58	.22	1.7	10	.19
	1 BC	10/18	4.8	7.4	108	108	.01	.01	.001	.03	.08	.05	1.0	10	.40
	Av.		6.5	7.8	99	101	.02	.01	.001	.10	.26	.12	1.5	10	.23
Blackfoot Riv.	2 BC	7/10	6.0	7.8	100	92	.01	.26	.001	.03	.22	.09	1.4	10	.03
	2 BC	8/16	6.8	8.1	96	100	.01	.01	.001	.04	.14	.07	2.1	10	.15
	2 BC	9/17	6.8	8.1	96	104	.01	.40	.001	.01	.07	.06	1.4	10	.41
	2 BC	10/18	4.8	7.2	112	120	.01	.01	.001	.03	.13	.06	.9	10	.02
	Av.		6.1	7.8	101	104	.01	.17	.001	.03	.14	.07	1.5	10	.15
Kendall Cr.	1-K	7/15	.4	7.6	76	--	.01	.14	.005	.02	.03	.03	.7	10	.01
	1-K	8/15	3.2	7.5	88	84	.01	.22	.001	.01	.02	.03	1.0	10	.76
	1-K	9/16	3.2	7.1	96	96	.01	.37	.001	.01	.02	.04	.9	10	.01
	Av.		2.3	7.4	87	90	.01	.24	.002	.01	.02	.03	.9	10	.26
Kendall Cr.	2-K	7/15	2.4	7.4	92	92	.01	.01	.001	.02	.10	.04	.6	10	.01
	2-K	8/15	--	--	--	--	--	--	--	--	--	--	--	--	.06
	2-K	9/16	7.6	7.8	84	84	.01	.28	.001	.03	.11	.06	.8	10	.01
	2-K	10/18	5.2	7.5	88	88	.01	.25	.001	.03	.03	.06	.9	10	.01
	Av.		5.1	7.6	88	88	.01	.18	.001	.03	.08	.05	.8	10	.02
Mill Cr.	1-M	7/10	8.0	8.4	92	--	.02	.09	.001	.01	.07	.05	2.3	10	.47
	1-M	8/15	7.6	7.5	124	132	.01	.31	.001	.02	.03	.03	1.5	10	.12
	1-M	9/16	16.8	8.4	92	128	.01	.71	.001	.01	.05	.07	1.4	10	.01
	1-M	10/17	9.2	8.0	92	92	.01	.41	.001	.01	.07	.04	1.2	10	.01
	Av.		10.4	8.1	100	117	.01	.38	.001	.01	.06	.05	1.6	10	.15
Mill Cr.	2-M	7/10	10.4	8.3	100	112	.01	.01	.001	.04	.15	.08	2.0	10	.09
	2-M	8/15	11.6	7.7	120	132	.01	.01	.001	.02	.09	.05	2.1	10	.29
	2-M	9/16	12.0	8.2	100	112	.01	.25	.001	.10	.36	.15	2.4	10	.10
	2-M	10/17	12.8	7.9	116	124	.01	.39	.001	.03	.15	.09	2.1	10	.01
	Av.		11.7	8.0	109	120	.01	.17	.001	.05	.19	.09	2.2	10	.12

(or 2.2) extends from 0.4 to 4.0 ppm. Correlated with this difference is the difference between the mean total organic carbon in Angus Creek, 2.2 ppm, and the mean total organic carbon in the Blackfoot River, 1.4 ppm. A test of these means revealed a significant difference at the 97.5% level. An even greater difference is experienced in the comparison of Kendall Creek and Mill Creek with the Blackfoot River. Kendall Creek having the least COD and Mill Creek the greatest of the 4 streams examined. The higher COD in Angus Creek and Mill Creek is sufficiently, but not necessarily, indicative of the possibility of septicity, saprophytic bacteria growth and diminished dissolved oxygen.

Field tests for dissolved oxygen, however, in 1973 disclosed adequate and favorable oxygen levels at all stations of the four streams within the study area (Table 8). The available water temperature data (Table 5) suggests compatible temperatures (33⁰-55⁰ F) for cutthroat trout.

Table 8 Dissolved oxygen (D.O.) in Angus Creek, Kendall Creek, Mill Creek and the Blackfoot River (ppm)

Stream	Station	D.O.	D.O.
		30-31 July 1973	4-5 Sept 1973
Angus Cr.	1-AC	12	13
	2-AC	12	13
	3-AC	11	--
	4-AC	10	13
	11-AC	13	14
Blackfoot River	1-BC	13	14
	2-BC	13	14
Kendall Cr.	1-K	13	13
	2-K	13	13
Mill Cr.	1-M	12	12
	2-M	12	12

Amounts of total solids and total dissolved solids compared with turbidity measurements show that the bulk of the watershed material being transported by Angus Creek out of the drainage is probably in the dissolved state. The turbidities and the total solids of Angus Creek and Mill Creek are not excessive and compare favorably with Kendall Creek (Tables 9 and 10). Moreover, no significant increase in turbidity occurred at the point of entrance of Angus Creek into the Blackfoot River. In the past, sediment and petroleum products, mainly in the form of waste oil, entering the upper reach of Angus Creek, have been contained by beaver dams, and thus have temporarily damaged only a small section of the stream. This damage, however, may be more extensive if the mining contemplated is undertaken without a change in pollution abatement procedures.

Kendall Creek

Heavy metals are no problem in Kendall Creek. Only iron is relatively high. Compared to the other streams, Kendall Creek samples had the lowest hardness (89 ppm), calcium (0.9 ppm), phosphorous (.04), phosphate (0.2), alkalinity (88 ppm), COD (3.7), pH (7.5) and total solids (195 ppm). Kendall Creek has low beaver activity and no perennial tributaries, which along with its short water course could account for the lower amount of water additives. All analysis shows that the Kendall Creek water is excellent for salmonids. The limiting factor to the fisheries is aquatic structure, not water quality.

Table 9. Hydrophysical data for Angus Creek and the Blackfoot River from 1970-1973 (JTU).

Date	Station	Turbidity	Date	Station	Turbidity
6/5/70	1AC	15	10/20/70	1AC	45
	2AC	17		2AC	50
	3AC	13		3AC	40
	4AC	35		4AC	40
	1BC	27		1BC	45
	2BC	21		2BC	62
6/22/70	1BC	21	4/20/71	1AC	5
	2BC	20		2AC	8
7/6/70				3AC	6
	1AC	25		4AC	11
	2AC	32		1BC	17
	3AC	14		2BC	10
	4AC	35	5/5/71		
	1BC	33		3AC	13
7/20/70	2BC	23	5/20/71	4AC	3
	1AC	23		1AC	6
	2AC	19		2AC	5
	3AC	16		3AC	4
	4AC	36		4AC	3
	1BC	45		1BC	2
8/28/70	2BC	28		2BC	8
	1AC	34	6/4/71	1AC	6
	2AC	31		2AC	4
	3AC	19		3AC	4
9/22/70	4AC	21		4AC	3
	1AC	22		1BC	8
	2AC	26		2BC	6
	3AC	30	5/16/72		
	4AC	15		1AC	9
	1BC	29		1BC	17
10/5/70	2BC	34		2BC	19
	1AC	25		3AC	23
	2AC	33		4AC	35
	3AC	38		5AC	14
	4AC	15		6AC	40
				7AC	45
				8AC	37
				9AC	7
				11AC	18
				12AC	8
			7/30/73	1AC	17
				2AC	19
				3AC	9
				4AC	25
				1BC	75
				2BC	30

Table 10 Hydrophysical data for Angus Creek, Kendall Creek, Mill Creek and the Blackfoot River for 1974

Stream	Station	Date	Total Solids (ppm)	Turbidity (JTU)
Angus Cr.	1-AC	7/9	220	35
	1-AC	8/16	228	42
	1-AC	9/16	240	35
	1-AC	10/17	236	33
	Av.		231	36
Angus Cr.	2-AC	7/9	215	28
	2-AC	8/15	227	42
	2-AC	9/16	220	35
	2-AC	10/17	217	38
	Av.		220	36
Angus Cr.	3-AC	7/9	201	37
	3-AC	7/10	199	35
	3-AC	8/15	211	35
	3-AC	9/16	213	45
	Av.		206	38
Angus Cr.	4-AC	8/16	208	47
	4-AC	9/17	207	33
	4-AC	10/17	219	31
	4-AC	10/18	219	40
	Av.		213	38
Angus Cr.	8-AC	7/9	155	23
Blackfoot Riv.	1-BC	7/10	212	37
	1-BC	8/16	216	47
	1-BC	9/17	228	50
	1-BC	10/18	228	43
	Av.		221	44
Blackfoot Riv.	2-BC	7/10	223	43
	2-BC	8/16	211	45
	2-BC	9/17	219	44
	2-BC	10/18	226	35
	Av.		220	42
Kendall Cr.	1-K	7/15	183	30
	1-K	8/15	191	36
	1-K	9/16	185	27
	Av.		186	31
Kendall Cr.	2-K	7/15	201	42
	2-K	9/16	216	40
	2-K	10/18	191	33
	Av.		203	38
Mill Cr.	1-M	7/10	240	41
	1-M	8/15	222	32
	1-M	9/16	215	39
	1-M	10/17	204	35
	Av.		220	37
Mill Cr.	2-M	7/10	236	41
	2-M	8/15	246	40
	2-M	9/16	239	40
	2-M	10/17	237	40
	Av.		240	40

Mill Creek

Mill Creek, the smallest of the streams studied, has no chemical condition that stands out from the other streams. The pH was higher (8.1), but is still within the limits of salmonid tolerance. Turbidity averaged the highest, but this may have been due to the mine dump bleeding sediment into Mill Creek during surface flow runoffs. The Mill Creek water is of sufficient quality, but, because of its small size, this stream will never carry an important trout population.

Blackfoot River

Water chemistry was monitored at stations 1BC and 2BC in the Blackfoot River to document site conditions and determine whether Angus Creek is influencing or will influence the Blackfoot River. The water at these stations has a longer exposure to terrestrial conditions than the water at stations in other streams. The small number of samples makes it difficult to analyze the influence from Angus Creek, but the available information indicates there is no significant influence at this time. The data does provide documentation for comparison with future information. Total solids averaged higher in the samples collected in the Blackfoot River than in the other streams.

From observing the Blackfoot system and using fish population and macroinvertebrate information to attempt to gauge water conditions, it appears the Blackfoot River is high in maturity. If conditions that favor a higher maturity - e.g., increased temperature, total solids, phosphate, and nitrogen - are increased, the system could be

further dominated by less desirable fish species. Blackfoot system probably needs a reduction in those conditions that lead to the development of maturity.

MACROINVERTEBRATES

(An abridgement of Shaw and Newell, 1974, and Pace 1975)

The constant sensitivity of certain benthos to toxic conditions permit their use as another aquatic monitoring tool to be employed with fish standing crop, fish species composition, fish production, and all other indicators tied to the aquatic structural complex (Gaufin and Tarzwell, 1952, 1956). Thus, benthic macroinvertebrates were collected in the upper Blackfoot River, Angus Creek, Mill Creek, and Kendall Creek with the objective (1) to compile a list of the fauna at selected stations on these streams, (2) to document benthic macroinvertebrate species diversity, species composition, and community structure at each station, and (3) to assay biologically for the presence of pollutants by using a stream comparison.

The collections were taken during the late summer and early fall of 1973 and 1974 at ten study stations by Forest Service personnel from the Soda Springs Ranger District (Figure 4). The first collection year (1973) established the identities, numbers, and diversities of the macroinvertebrates within the defined stations. Information collected the subsequent year (1974) allowed a temporal comparison of the population status of the benthic macroinvertebrates.

During 1974, macroinvertebrates representing four phyla, eight classes, nine orders, forty-eight families, and seventy-two genera were collected (Table 11). Most of the taxa represented, however, is subsumed under the Arthropoda; the Arthropods accounting for 73 of the ultimate classifications. Only two minor differences were noted between

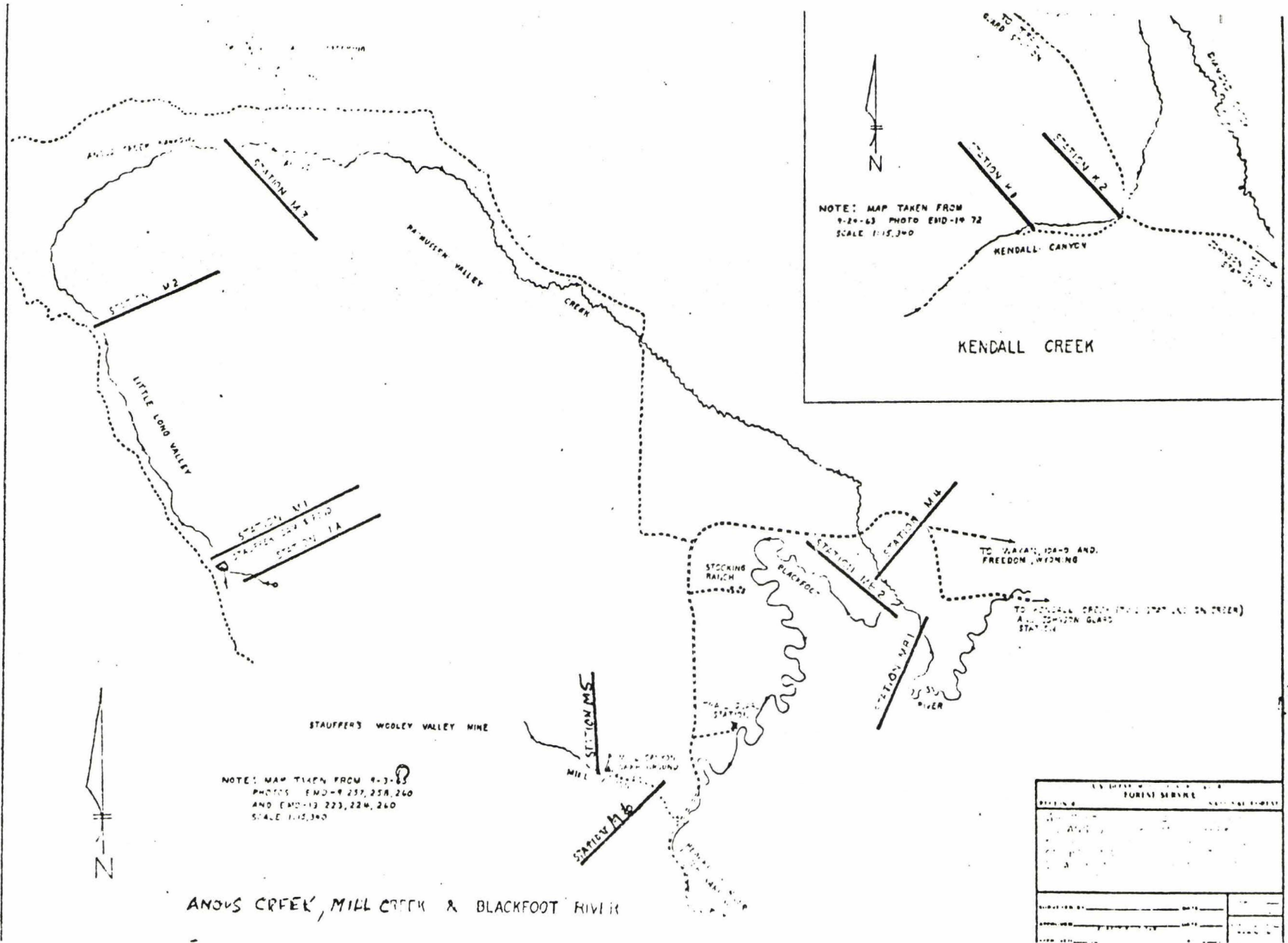


Figure 4. Location of benthic macroinvertebrate collection stations on Angus Creek, Mill Creek, Kendall Creek and the Blackfoot River.

Table 11. Macroinvertebrates collected from the Blackfoot River, Angus Creek, Kendall Creek, and Mill Creek from August to October, 1974.

PHYLUM PLATYHELMINTHES

Class Turbellaria

PHYLUM ANNELIDA

Class Hirudinea

Family Glossiphoniidae

Glossiphonia sp.

Family Piscicolidae

Class Oligochaeta

Family Lumbriculidae

Family Tubificidae

PHYLUM ARTHROPODA

Class Arachnida

Order Acari

Superfamily Hydracnoidea

Superfamily Hygrobatoidea

Class Eudrustacea

Order Amphipoda

Gammarus sp.

Hyalella sp.

Class Insecta

Order Coleoptera

Family Elmidae

Cleptelmis sp.

Dubiraphia sp.

Heterlimnius corpulentus

Optioservus sp.

Zaitzevia parvula

Family Dytiscidae

Agabus sp.

Family Haliplidae

Brychius sp.

Haliplus sp.

Family Hydraenidae

Hydraena sp.

Family Hydrophilidae

Ametor scabrosus

Order Diptera

Family Ceratopogonidae

Family Chironomidae

Family Dixidae

Dixa sp.

Family Empididae

Family Liriopidae

Liriop sp.

Family Muscidae

Limnophora sp.

Family Psychodidae

Pericoma sp.

Family Rhagionidae

Atherix variegata

Family Simuliidae

Simulium sp.

Family Stratiomyidae

Family Tipulidae

Antocha sp.

Hexatoma sp.

Limnophila sp.

Tipula sp.

Order Ephemeroptera

Family Ephemerellidae

Ephemerella coloradensis

E. doddsi

E. grandis

E. hecuba

E. inermis

Family Heptageniidae

Cinygmula sp.

Heptagenia sp.

Rithrogena sp.

Family Leptophlebiidae

Leptophlebia sp.

Paraleptophlebia sp.

Family Siphonuridae

Ameletus sp.

Family Baetidae

Baetis sp.

Family Tricorythidae

Tricorythodes sp.

Order Hemiptera

Family Corixidae

Order Megaloptera

Family Sialidae

Sialis sp.

Order Plecoptera

Family Chloroperlidae

Alloperla sp.

Family Nemouridae

Brachyptera sp.

Capnia sp.

Nemoura sp.

Paraleuctra prob. sara

Family Perlidae

Acroneuria pacifica

Family Perlodidae

Arcynopteryx parallela

A. signata

Isogenus aestivalis

Isogenus sp.

Isoperla sp.

-
- Family Pteronarcidae
 - Pteronarcella badia
 - Pteronarcys californica
 - Order Trichoptera
 - Family Brachycentridae
 - Brachycentrus sp.
 - Family Helicopsyche
 - Helicopsyche borealis
 - Family Hydropsychidae
 - Cheumatopsyche sp.
 - Hydropsyche sp.
 - Family Hydroptilidae
 - Family Lepidostomatidae
 - Lepidostoma sp.
 - Family Leptoceridae
 - Athripsodes sp.
 - Trienodes sp.
 - Family Limnephilidae
 - Ecclisomyia sp.
 - Hesperophylax sp.
 - Limnephilus sp.
 - Neothremma sp.
 - Oligophlebodes sp.
 - Radema sp.
 - Family Philopotamidae
 - Wormaldia sp.
 - Family Rhyacophilidae
 - Glossosoma sp.
 - Rhyacophila sp.

PHYLUM MOLLUSCA

- Class Gastropoda
 - Family Ancyliidae
 - Ferrissia sp.
 - Family Bulimidae
 - Fluminicola sp.
 - Family Lymnaeidae
 - Lymnaea sp.
 - Family Planorbidae
 - Gyraulus sp.
 - Family Physidae
 - Physa sp.
- Class Pelecypoda
 - Family Sphaeriidae
 - Pisidium sp.

the collections of the two years. In 1973, individuals of the family Ephydriidae, order Diptera, class Insecta, were found, but were not encountered in the samples of 1974. Ephemerella hecuba, family Ephemerellidae, order Ephemeroptera, class Insecta, occurred in the 1974 collections, but not in those of 1973.

Insects belonging to 5 orders and miscellaneous other organisms were compared among stations and among years (Table 12). The mean number of taxa represented by the organisms of each station in 1973 is 39.7, whereas in 1974 the mean is 46.5. This increase reflects increases in the organisms found which belong to the following listed orders: Coleoptera, Ephemeroptera, Plecoptera and Trichoptera. Members of these orders generally require for survival moderately fast to fast flowing unpolluted water.

In Table 13 a summary of the total collected macroinvertebrates, classified by major taxonomic groups, gives a comparison among stations and years, and Table 14 compares the species diversity indices for all the sampling stations for 1973 and 1974. The diversity indices in 1974 ranged from 3.1 to 4.1. Low diversity occurred at station M3 on Angus Creek, where the community was composed of a few numerically dominating taxa - Ephemerella, Nemoura, Chironomidae, and Simulium. High diversity occurred at station M-4 on Angus Creek, where abundance was more evenly distributed among the major taxonomic groups. Station M3 is influenced by beaver activity and station M4 is in a unblocked stream area. Equitability values ranged from 0.6 to 0.7, and redundancy values from 0.3 to 0.4 in the four streams in 1974.

Table 12. Comparison among stations and years of the macroinvertebrates collected during September-November 1973 and August-October 1974

Organism	Stations															
	Kendall Cr.				Angus Cr.								Blackfoot Riv.			
	K-1	K-2			IA	M-2	M-3	M-4					MB-1	MB-2	M-5	M-6
Ephemeroptera:	'73	'74	'73	'74	'73	'74	'73	'74	'73	'74	'73	'74	'73	'74	'73	'74
<u>Ameletus</u>	*		*	o		o	*	o	*	o	*	o	*	o	*	o
<u>Baetis</u>	*	o	*	o	*	o	*	o	*	o	*	o	*	o	*	o
<u>Cinygmula</u>	*	o	*	o			*	o	*	o	*	o	*	o	*	o
<u>Ephemerella coloradensis</u>	*	o	*	o				o		o		o		o		o
<u>Ephemerella doddsi</u>	*		*	o				o		o		o		o	*	o
<u>Ephemerella grandis</u>	*	o	*		*	o	*	o	*	o	*	o	*	o	*	o
<u>Ephemerella inermis</u>	*	o	*				*	o		o	*	o	*	o	*	o
<u>Heptagenia</u>				o						o		o	*	o		o
<u>Heptageniidae</u>	*		*		*		*		*		*		*	o	*	
<u>Leptophlebia</u>									*			o		o		
<u>Paraleptophlebia</u>		o	*	o		o	*	o	*	o	*	o	*	o	*	o
<u>Rithrogena</u>				o						o	*	o	*	o		
<u>Tricorythodes</u>									*	o	*		*	o		
<u>Ephemerella hecuba</u>														o		
TOTAL	7	6	8	8	3	4	6	8	5	8	8	11	7	10	8	9
Plecoptera:																
<u>Acroneuria</u>		o		o		o					*	o	*	o		o
<u>Alloperla</u>	*		*	o		o	*	o	*	o	*	o	*	o	*	o
<u>Arcynopteryx</u>	*	o	*	o		o		o	*	o	*	o	*	o		o
<u>Brachyptera</u>				o								o		o	*	o
<u>Capnia</u>	*	o	*				*	o	*	o	*	o	*		*	o
<u>Isogenus</u>	*	o	*	o		o	*	o				o		o		
<u>Isoperla</u>			*	o	*	o	*	o			*		*	o		*
<u>Nemoura</u>	*	o	*	o	*	o	*	o	*	o	*	o	*	o	*	o
<u>Paraleuctra</u>								o								o
<u>Perlodidae</u>	*		*		*		*		*		*		*		*	
<u>Pteronarcella</u>											*			o	*	
<u>Pteronarcys</u>			*						*	o	*	o	*	o	*	
TOTAL	5	5	7	7	2	6	5	6	4	5	7	8	8	7	6	9

Table 12. Continued

Organism	Stations																			
	Kendall Cr.				Angus Cr								Blackfoot Riv				Mill Cr			
	K-1		K-2		IA		M-2		M-3		M-4		MB-1		MB-2		M-5		M-6	
Trichoptera:	'73	'74	'73	'74	'73	'74	'73	'74	'73	'74	'73	'74	'73	'74	'73	'74	'73	'74	'73	'74
<u>Athripsodes</u>					*		*	o	*	o	*	o	*	o	*	o	*		*	o
<u>Brachycentrus</u>				o							*	o	*	o	*	o				
<u>Cheumatopsyche</u>	*		*				*			o	*	o	*	o	*	o		o		
<u>Ecclisomyia</u>	*	o	*	o	*	o		o	*	o		o					*	o	*	o
<u>Glossosoma</u>			*		*							o	*	o	*		*			
<u>Helicopsyche</u>							*				*	o	*	o	*	o				
<u>Hesperophylax</u>					*	o		o	*			o	*		*				*	
<u>Hydropsyche</u>		o	*			o	*	o	*		*	o	*	o	*	o		o		o
<u>Hydroptilidae</u>		o	*	o			*	o	*	o	*	o	*	o	*	o	*	o		
<u>Lepidostoma</u>													*	o	*		*			o
<u>Limnephilidae</u>	*	o	*		*	o	*		*		*		*		*		*		*	
<u>Limnephilus</u>				o		o	*	o	*	o		o		o		o		o		o
<u>Neothremma</u>	*	o	*	o								o	*		*		o			
<u>Oligophlebores</u>	*	o	*	o													o			
<u>Radema</u>			*	o				o	*	o					*		o			o
<u>Rhyacophila</u>	*	o	*	o	*		*	o	*	o	*	o	*		*		*	o	*	o
<u>Triaenodes</u>														o						
<u>Wormaldia</u>								o	*	o	*	o	*			o	*	o		
Unknown pupae	*									o										
TOTAL	6	7	9	8	5	5	7	9	9	9	9	13	12	10	10	8	7	10	4	7
Diptera:																				
<u>Antocha</u>			*						*	o		o	*	o	*	o		o		
<u>Atherix</u>			*		*	o	*			o	*	o	*	o	*	o	*	o		
<u>Ceratopogonidae</u>	*				*	o	*		*	o	*		*	o	*	o	*	o	*	o
<u>Chironomidae</u>	*	o	*	o	*	o	*	o	*	o	*	o	*	o	*	o	*	o	*	
<u>Dixidae</u>					*	o	*	o	*										*	
<u>Empididae</u>	*	o	*	o	*				*		*	o	*		*			o	*	
<u>Ephydriidae</u>					*										*					
<u>Hexatoma</u>					*			o										o		

Table 12. Continued

Organism	Stations																			
	Kendall Cr.				Angus Cr.								Blackfoot Riv.				Mill Cr.			
	K-1		I-2		IA		M-2		M-3		M-4		MB-1		MB-2		M-5		M-6	
	'73	'74	'73	'74	'73	'74	'73	'74	'73	'74	'73	'74	'73	'74	'73	'74	'73	'74	'73	'74
Liriopedidae						o	*							o						
<u>Limnophora</u>	*	o			*	o	*	o			*	o								o
<u>Pedicia</u>			*			o	*	o	*		*						*			
<u>Pericoma</u>	*	o	*	o		o	*	o	*	o	*						*	o	*	o
<u>Simulium</u>	*	o	*	o	*	o	*	o	*	o	*	o	*	o	*	o	*	o	*	o
Stratiomyiidae	*		*	o	*	o	*	o		o							*	o	*	o
Tipulidae	*	o	*	o	*	o	*	o	*	o	*	o	*	o	*	o	*	o	*	
TOTAL	8	6	8	6	10	11	10	9	8	8	8	7	5	7	7	5	7	11	8	5

Coleoptera:

Agabus		o			*	o		o	*			o								
Ametor		o				o		o										o		
Brychius							*	o		o	*	o		o		o				
Cleptelmis		o	*	o		o	*	o	*	o	*	o	*	o	*	o	*	o	*	o
Dubiraphia										o		o							*	
Dytiscidae	*			o	*	o	*		*		*	o		o	*	o		o		
Elmidae	*		*		*		*		*		*		*		*		*		*	
Heterlimnius		o	*	o				o	*	o		o	*	o		o	*	o		o
Haliplidae	*						*		*		*		*		*					
Haliphus							*	o				o		o						
Hydraena								o		o	*	o				o	*	o		o
Hydrophilidae					*						*	o					*	o		
Optioservus	*	o	*	o	*	o	*	o	*	o	*	o	*	o	*	o	*	o	*	o
Zaitzevia								o		o			*	o				o		
Unknown	*																*		*	
TOTAL	4	5	3	4	3	5	5	9	6	6	6	10	5	7	4	6	6	8	4	4

Table 12. Continued

Organism	Stations																	
	Kendall Cr.				Angus Cr.								Blackfoot Riv.				Mill Cr.	
	K-1	K-2			IA			M-2	M-3	M-4			MB-1	MB-2			M-5	M-6
Miscellaneous:																		
Acari	'73	'74	'73	'74	'73	'74	'73	'74	'73	'74	'73	'74	'73	'74	'73	'74	'73	'74
Corixidae	*	o	*	o	*	o	*	o	*	o	*	o	*	o	*	o	*	o
Ferrissia	*	o	*	o							*	o	*	o	*	o	*	o
Fluminicola	*	o	*		*	o	*	o	*	o		o	*		*	o		o
Gammarus							*	o			*	o		o				
Glossiphonia					*	o				o	*	o		o	*	o		o
Gyraulus		o				o		o			*	o	*					o
Hyalélla			*				*				*			o			*	
Lumbriculidae		o		o	*	o					*	o	*	o				
Lymnaea		o		o	*	o	*	o	*	o	*	o	*	o	*	o	*	o
Physa			*							o								
Piscicolidae		o	*	o	*	o	*	o		o	*	o		o		o	o	*
Pisidium															*			
Sialis			*		*							o						
Tubificidae		o		o	*	o	*	o	*	o	*	o	*		*	o	o	o
Turbellaria	*	o	*	o	*	o	*	o	*	o	*				*	o	*	o
TOTAL	4	9	8	7	9	9	8	8	5	8	11	12	8	8	8	8	5	5
GRAND TOTAL	34	38	43	40	32	40	41	49	37	44	49	61	45	39	42	49	37	49

Table 13. Comparison among stations and years of the total number of macroinvertebrates in major taxonomic groups collected during the periods September-November 1973 and August-October 1974.

Organism	Stations																			
	Kendall Cr.				Angus Cr.								Blackfoot River				Mill Cr.			
	K-1		K-2		IA		M-2		M-3		M-4		MB-1		MB-2		M-5		M-6	
	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974
Acari	61	77	131	281	7	8	277	270	28	17	62	236	2551	1619	940	872	382	417	177	335
Amphipoda	1	197	1	---	596	826	1541	1076	1	4	1	22	4	---	4	---	---	---	---	1
Coleoptera	104	85	132	94	24	21	268	304	92	103	553	254	4015	1300	1406	684	695	431	318	1048
Diptera	1395	394	212	286	1280	1303	1413	838	919	1588	2893	1093	18930	3306	12723	3300	1780	935	1027	989
Ephemeroptera	2190	477	834	1317	35	116	257	715	1501	1714	3208	2696	11822	7570	7145	4996	2106	1742	718	747
Miscellaneous	---	---	4	---	1	---	5	1	---	1	6	24	2	2	---	---	1	---	1	---
Mollusca	1	30	38	55	98	134	50	133	503	116	530	874	188	410	433	458	29	6	25	18
Oligochaeta	---	132	---	4	19	53	275	153	4	8	447	7	322	4	62	10	---	19	---	12
Plecoptera	361	125	468	303	969	555	548	897	2050	1861	819	341	540	489	394	242	2374	1730	1475	1763
Trichoptera	940	788	759	865	159	449	61	227	55	120	2986	2685	1601	864	695	560	540	481	302	481
Turbellaria	1953	156	1254	1275	1	1	1286	344	7	32	3	---	---	---	9	3	1250	1270	837	1044
TOTALS	7006	2456	3833	4480	3189	3466	5981	4956	5160	5564	11508	8080	39975	15564	23811	11125	9157	7030	4880	6434

Table 14. Comparison of the benthic macroinvertebrate indices for the years 1973 and 1974 for sampling stations on Angus Creek, Kendall Creek, Mill Creek, and the Blackfoot River. Values are based on total numbers of macroinvertebrates collected.

	Stations																			
	Kendall Cr.				Angus Cr.								Blackfoot River				Mill Cr.			
	K-1		K-2		IA		M-2		M-3		M-4		MB-1		MB-2		M-5		M-6	
	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974
Diversity Index	2.9	3.9	3.3	3.4	2.7	3.3	3.2	3.8	2.8	3.1	3.6	4.1	2.6	4.0	2.6	3.7	3.6	3.6	3.6	3.
Diversity Maximum	5.1	5.2	5.3	5.3	5.1	5.3	5.4	5.6	5.3	5.4	5.6	6.0	5.5	5.7	5.5	5.6	5.2	5.6	5.1	5.
Diversity Minimum	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.01	0.04	0.02	0.06	0.1	0.09	0.1	0.
Equitability	0.3	0.7	0.3	0.6	0.2	0.6	0.3	0.7	0.2	0.6	0.4	0.7	0.2	0.7	0.2	0.7	0.5	0.6	0.5	0.
Redundancy	0.4	0.3	0.4	0.4	0.5	0.4	0.4	0.3	0.5	0.4	0.4	0.3	0.5	0.3	0.5	0.3	0.3	0.4	0.3	0.
Number of taxa in analysis	35	38	42	40	36	40	44	49	41	44	50	64	46	51	46	50	38	49	36	4
Total number of invertebrates	7006	2456	3833	4480	3187	3466	5981	4956	5160	5564	11508	8080	39975	15564	23811	11125	9157	7030	4880	64

Both years showed a large number of different types of macroinvertebrates. Many of the organisms are abundant, but none dominate any one station. The community composition of macroinvertebrates also remained quite similar over the two-year period, expressing no significant population changes. In Kendall Creek, Mill Creek and the Blackfoot River, the predominant forms processed for both years at all stations are those generally found in moderately-fast and fast flowing streams - e.g., Baetis, Ephemerella, Heptageniidae, Nemoura, Perlodidae, Chloroperlidae, Limnephilidae, Rhyacophilidae, Elmidae, and Turbellaria. These streams in the area sampled have insignificant beaver influence. In Angus Creek the macroinvertebrates of stations 1-A and M-2 differed appreciably from those found at stations M-3 and M-4: slow flowing water forms (Nemoura, Gammarus and Turbellaria) were abundantly present at stations 1-A and M-2, whereas faster flowing water forms (Chloroperlidae, Ephemerella and Hydropsychidae) were commonly found at stations M-3 and M-4. Stations 1-A and M-2 are within a long series of beaver impoundments. M-3 does have some beaver influence but M-4 does not.

Individuals within the orders Ephemeroptera, Plecoptera and Trichoptera are highly sensitive to organic pollutants (Gaufin and Tarzwell, 1952, 1956). A comparison of the ranges of discrete taxa within each indicator order in the upper Blackfoot River and its tributaries with the ranges of discrete taxa in known-polluted and known-unpolluted streams of southeastern Idaho shows the upper Blackfoot River area to be relatively free of pollutants (Table 15). In the upper Blackfoot River system the numbers of discrete taxa in all orders ranged in 1973 from 45 to 66 and in 1974 from 56 to 80: these ranges compare favorably with the range 51 to 91 of known-unpolluted streams. In the same river

Table 15. Comparison of the number of total discrete taxa and discrete taxa in three indicator orders in the Blackfoot River, Kendall Creek, Angus Creek, and Mill Creek with the number of the same discrete taxa in known-polluted and known-unpolluted streams of southeastern Idaho.

Orders	Number of Discrete Taxa								Known-Polluted Streams	Known-Unpolluted Streams
	Blackfoot River		Kendall Cr.		Angus Cr.		Mill Cr.			
	1973	1974	1973	1974	1973	1974	1973	1974		
All orders	53	62	50	56	66	80	45	58	28	51-91
Ephemeroptera	8	13	8	10	9	12	5	9	4	5-20
Plecoptera	8	10	7	8	8	10	9	9	1	6-24
Tricoptera	12	11	10	10	12	16	8	12	3	8-25

system the ranges of discrete taxa of Ephemeroptera (5-9 in 1973) (9-13 in 1974), of Plecoptera (7-9 in 1973) (8-10 in 1974) and of Trichoptera (8-12 in 1973) (10-16 in 1974) also are more in accord with the ranges in known-unpolluted streams than with the ranges in known-polluted streams.

A comparison of the macroinvertebrate fauna of the upper Blackfoot River and its tributaries with the macroinvertebrate fauna of streams polluted with organic and toxic wastes indicates gross dissimilarities. A septic zone fauna typical of streams polluted with organic sewage consists predominately of oligochaetes, pulmonate snails, rattail maggots and mosquito and midge larvae. A recovery zone usually includes a lesser proportion of the septic zone forms and a larger proportion of blackfly larvae, mayfly nymphs and caddis fly larvae (Gaufin and Tarzwell, 1952, 1956). Many of the typical recovery zone organisms are present in the Blackfoot River streams studied, but not in abundance or relative percentages characteristic of organically-degraded streams. A stream polluted with toxic inorganic wastes (silt, acids, metals, e.g.) typically suffers a severe reduction in the number of species, sometimes to as few as eight or nine (Parsons, 1968). However, with a range of 45 to 66 taxa at the various stations, the upper Blackfoot River system cannot be characterized as severely depleted in species.

Wilhm (1970) found that in 21 streams listed as clean or recovered mean diversity ranged between 2.60 to 4.61, whereas in 21 streams polluted by various discharges indices ranged between 0.42 to 1.60. The mean diversity indices for the upper Blackfoot River and tributaries for 1973 and 1974 fall well within the range of the clean or recovered streams.

FISHERIES

Angus Creek

Angus Creek is the typical small, mountain stream that contributes to the tributary mix that makes the Blackfoot River system such an excellent sports fishery. The stream supports about 1200 cutthroat trout per mile (Table 16) which, compared with other small Idaho streams, is a high standing crop. With both salmonid spawning and rearing areas available, the cutthroat trout of Angus Creek includes not only instream resident cutthroat trout but also migrating adult cutthroat trout spawners from the Blackfoot system. These cutthroat trout spawn in Angus Creek and, as some of their progeny, return to the Blackfoot River and Reservoir. The resident cutthroat trout populations of Angus Creek also propagate an outflow of juveniles that will rear and be harvested in the same areas as the migrating strains. The average size of the cutthroat trout in Angus Creek was only 4.5 inches (Table 17).

The first 1,000 feet of the Angus Creek in the headwaters, except the reservoir, is barren of fish, probably because of winter conditions and beaver dams restricting upstream fish passage. The reservoir is presently carrying a large population of cutthroat trout. From this reservoir in the headwaters to the lower end of the Angus Creek Narrows, the stream is dominated by cutthroat trout. As the stream enters private lands, below the Narrows, cutthroat trout numbers per unit area decrease and nongame fish numbers increase. The lower reach of Angus Creek, immediately above Angus Creek's confluence with the Blackfoot River, is dominated by nongame species (dace, sucker, redbside shiner and sculpin), but cutthroat trout are also found.

Table 16. Summary of the sampling of the fish populations in Angus Creek during the years 1971-1974

Date	Station	Fish Type							Annual Totals
		Cutthroat Trout			Dace	Shiners	Suckers	Sculpin	
		No.	Mean Size (in)	Size Range (in)	No.	No.	No.	No.	
1971:8/11	1	8	5.5	2.0-8.0	*	*	*	*	8
do	3	11	6.5	4.0-8.0	*	*	*	*	11
do	4	16	6.5	4.0-8.0	*	*	*	*	16
		35	6.3	2.0-8.0	*	*	*	*	35
1972:7/13	1	9	6.0	4.1-11.0	230	14	27	5	285
do	2	4	5.0	4.5-5.5	140	10	20	30	204
do	3**	---	---	---	7	0	0	0	7
do	4	15	5.8	3.0-12.0	0	0	0	0	15
do	5	5	4.5	4.0-5.0	40	20	26	40	131
do	6	---	---	1.0-13.0	0	0	0	6	58
do	8	244	---	1.0-10.0	0	0	0	0	244
		329	5.6	1.0-13.0	417	44	73	81	944
1973:8/21	1	12	4.4	1.0-5.4	31	0	31	9	83
do	2	16	4.7	2.6-6.8	9	0	8	16	49
do	4	17	5.7	3.6-8.5	14	14	14	12	71
do	5	20	3.9	1.8-6.2	0	0	0	8	28
do	6	28	4.8	1.6-11.9	0	0	0	21	49
do	8	72+*** (97)	4.4	1.8-10.3	0	0	0	0	72
do	9	---****	---	---	---	---	---	---	---
		165	4.6	1.0-11.9	54	14	53	66	352
1974:8/20	1	2	5.9	5.8-6.0	36	0	0	0	38
do	2	9	5.3	4.8-7.6	26	0	3	30	68
do	3	0	---	---	21	0	22	3	46
do	4	5	6.0	5.2-7.6	23	5	8	14	55
do	5	12	5.2	4.0-7.2	0	0	0	2	14
do	6	45	4.8	1.6-12.3	0	0	0	12	57
do	8	72	2.5	1.6-12.1	0	0	0	2	74
do	9****	---	---	---	---	---	---	---	74
		145	3.8	1.6-12.3	106	5	33	63	352

*Present in large, but unknown, numbers

**High water from beaver activity interfered with use of electroshockers

***Observed, but did not catch, an additional 97 cutthroats, 1.5 to 4.0 inches

Table 17. Length frequency of cutthroat trout sampled in Angus Creek, 21 August 1973

Station	Size (in)										
	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5
1	1	0	1	5	5	0	0	0	0	0	0
2	0	2	1	11	1	1	0	0	0	0	0
4	0	0	1	6	2	4	3	1	0	0	0
5	1	5	4	5	3	2	0	0	0	0	0
6	1	4	12	3	1	2	2	0	0	0	3
8	1	2	31	20	8	4	2	1	1	2	0
9*	0	0	0	0	0	0	0	0	0	0	0
TOTAL	4	13	50	50	20	13	7	2	1	2	3

*Devoid of water because of mining use

All stations (Figure 5) on Angus Creek, except station 9, have cutthroat trout within their boundaries. The section of stream covered by station 9 is now ephemeral each summer, because of water demands for the sprinkling of the roads by the mining company. No cutthroat trout were collected at station 3 in 1972, because this area was inundated by high water from beaver dams, precluding the use of electro fish collectors. In 1974, station 3 was moved laterally to a running side channel.

Fish standing crops show some temporal variation but no indication, except at station 9, that mining has had any adverse effect on the fisheries. After natural population fluctuations are discounted, the Angus Creek aquatic environment and fisheries from station 8 downstream to station 1 is quite stable. The stream area represented by station 9 has been altered by mining by the extraction of the water and addition of fine sediment.

Kendall Creek

Kendall Creek does not have sufficient suitable environment for salmonids and therefore is sparsely inhabited by a limited number of cutthroat trout and probably by a few brook trout and sculpins (Platts, 1975). The population density has been estimated as 26 trout per mile (ibid), this estimate being based on the sampling efforts in October of 1974 (Table 18). Salmonid spawning areas, though of minor extent, are available.

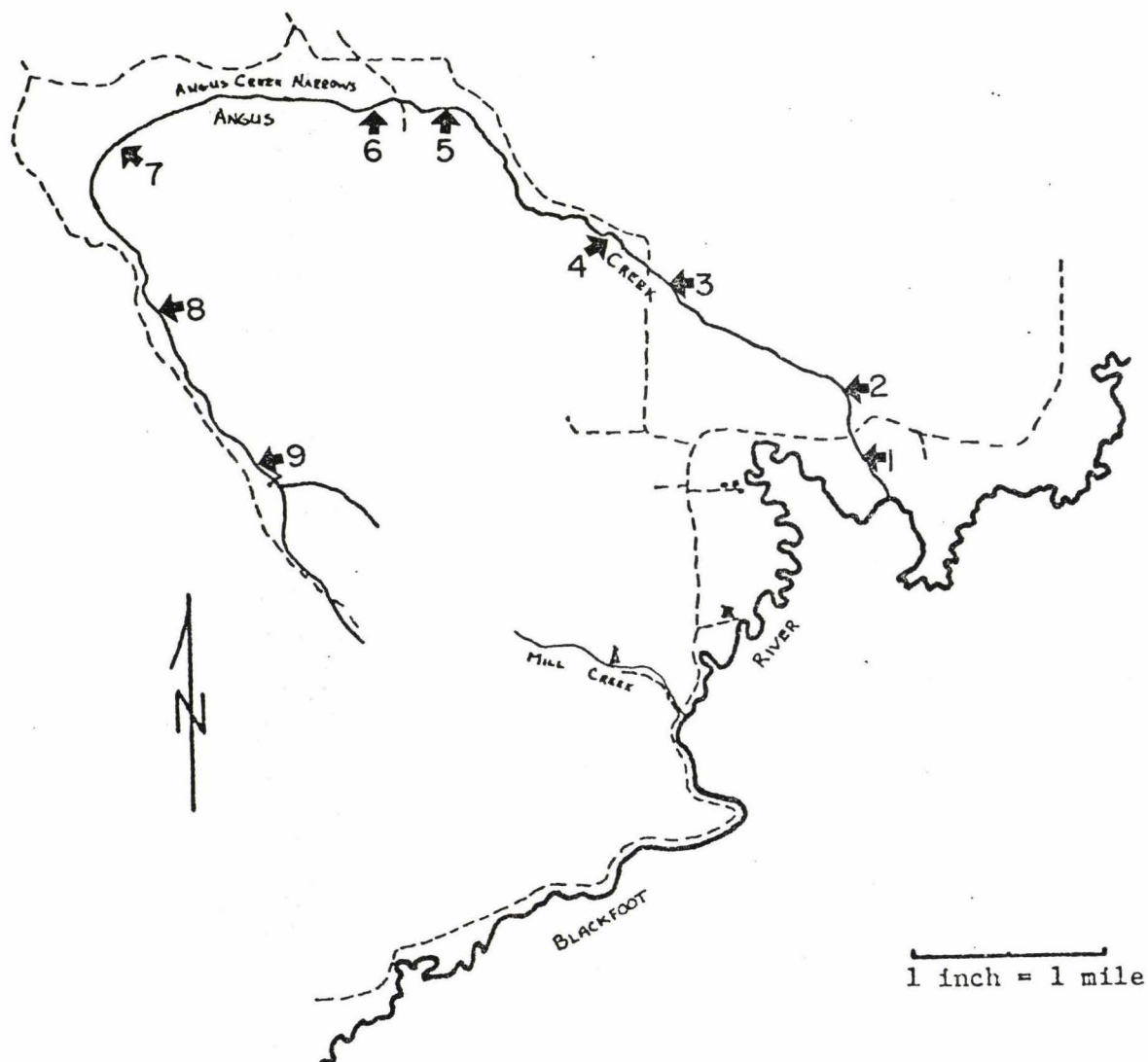


Figure 5. Location of electrofish sampling stations on Angus Creek.

Table 18. Fish species, number and size collected in Kendall Creek, October 1974

Species	Station			
	1-K		2-K	
	Number	Size (in)	Number	Size (in)
Cutthroat Trout	0	-	1	5.6
" "	0	-	1	6.6

Mill Creek

There is no available evidence of any species of fish inhabiting upper Mill Creek but small populations are found between the main road crossing and the Blackfoot River. From an evaluation of the stream parameters (mainly lack of water space and depth) it can be assumed that any population of fish attempting inhabitation would be severely restricted. The primary fisheries value of Mill Creek is that of a contributor of water to the Blackfoot River.

Blackfoot River

The upper Blackfoot River is extensively used for a sport fishery. During the months of May through September, 1971, 610 angler hours were observed, these efforts resulting in the catch of 18 rainbow trout and 252 cutthroat trout. The cutthroat trout averaged 11.2 inches (total length) and ranged from 7 to 20 inches (Heimer, 1972).

The Blackfoot River above and below the confluence of Angus Creek was sampled for fish standing crop (Table 19). The collection stations are recorded on District and zone aerial photographs. In 1973, above the confluence of Angus Creek, in the upper station, this river supported

over twice the number of cutthroat trout than the river supported in the lower station below Angus Creek. Cutthroat trout also averaged larger. Cutthroat trout collected in both sections of the Blackfoot River averaged over 11 inches in total length (Table 20). Other fish species collected were brown trout, sucker, dace, redbside shiner, and sculpin (Platts, 1975).

Table 19. Summary of the sampling of the fish population in the Blackfoot River on 22 August 1973.

Area	Fish Type						
	Cutthroat Trout			Rainbow Trout		Brook Trout	
	No.	Mean Size (in)	Size Range (in)	No.	Size (in)	No.	Size (in)
Upstream from Angus Creek	43*	11.7	2.0-21.3	1	14.1	1	12.1
Downstream from Angus Creek	19	9.8	2.0-19.2	0		0	
TOTAL	62	11.1		1	14.1	1	12.1

*Observed, but did not catch, 172 small cutthroat trout

Table 20. Length frequency of cutthroat trout sampled in the Blackfoot River above and below Angus Creek, 22 August 1973 (inches).

Area	Size										
	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	22.0
Above Angus Cr.	1	4	7	2	4	7	8	4	3	2	1
Below Angus Cr.	0	1	6	4	0	6	1	0	1	0	0
TOTAL	1	5	13	6	4	13	9	4	4	2	1

MONITORING - CHEMICAL AND PHYSICAL

To monitor for any inception, or any increase, in pollution occurring from diverse land use activities within the drainages of the upper Blackfoot River, Angus Creek, Kendall Creek and Mill Creek, additional chemical and physical information was taken at five study stations repeatedly but intermittently from August 1974 to July 1975 (Tables 21-25) by Dennis Kelly, Caribou National Forest:

<u>Station</u>	<u>Location</u>
1	Upper Blackfoot River, immediately downstream from the boundary of the Caribou National Forest.
2	Angus Creek, immediately below the 1972 sediment retention dam and above a planned extension of the Wooley Valley Mine.
3	Angus Creek, 1/2 mile above the Caribou National Forest property line.
4	Kendall Creek, 100 yards below the Caribou National Forest boundary.
5	Mill Creek, (tributary to Diamond Creek) 100 yards upstream from the Caribou National Forest property line.

To obtain the characteristic water quality conditions for the upper Blackfoot River system, information from other streams were also used. Information from Diamond, Maybe, Sheep, and Stewart Creeks was used to gain an overall documentation picture (Table 26).

Table 21. Chemical and physical statistics of Angus Creek, near headwaters (Kelly).

PARAMETER			NUMBER	MEAN	VARIANCE	MAXIMUM	MINIMUM	BEG DATE	END DATE
WATER	TEMP	FAHN	35	42.7	95.0	66.0	32.0	74/08/20	75/07/08
AIR	TEMP	FAHN	35	45.1	217.0	74.0	15.0	74/08/20	75/07/08
CLOUD	COVER	PERCENT	38	48.5	1639.0	100.0	.0	74/08/20	75/07/08
STREAM	FLOW	INST-CFS	11	.84	2.04	3.25	.01	74/08/20	75/06/16
STREAM	STAGE	FEET	37	.87	.112	1.59	.56	74/08/20	75/07/08
TURB	TRBIOMTR	HATCH FTU	38	7.8	107.0	35.00	.4	74/08/20	75/07/08
CNDUCTVY	AT 25C	MICROMHO	37	337.2	8113.0	439.0	14.0	74/08/20	75/07/08
PH		SU	19	7.0	.13	7.6	6.4	74/10/16	75/06/04
LAB	PH	SU	3	8.2	.004	8.25	8.13	75/06/24	75/07/08
T ALK	CACO3	MG/L	37	175.0	3694.0	258.0	6.0	74/08/20	75/07/08
NO2-N	TOTAL	MG/L	24	.05	.002	.15	.00	75/03/18	75/07/08
NO3-N	TOTAL	MG/L	24	.30	.02	.60	.12	75/03/18	75/07/08
TOT KJEL	N	MG/L	37	2.6	1.05	5.1	.1	74/08/20	75/07/08
PHOS-TOT		MG/L P	35	.20	.06	1.05	.001	74/08/20	75/06/24
PHOS-DIS		MG/L P	24	.15	.01	.68	.07	75/03/18	75/07/08
TOT HARD	CACO3	MG/L	37	174.8	2861.0	240.0	8.0	74/08/20	75/07/08
ARSENIC	AS,TOT	UG/L	2	.00	.00	.00	.00	74/08/27	75/05/12
CADMIUM	CD,TOT	UG/L	2	.00	.00	.00	.00	74/08/27	75/05/12
CHROMIUM	CR,TOT	UG/L	2	9.4	.6	10.0	8.9	74/08/27	75/05/12
COPPER	CU,TOT	UG/L	2	6.1	.04	6.3	6.0	74/08/27	75/05/12
VANADIUM	V,TOT	UG/L	2	10.5	220.0	21.0	.0	74/08/27	75/05/12
ZINC	ZN,TOT	UG/L	2	10.5	111.0	13.0	3.1	74/08/27	75/05/12
SELENIUM	SE,TOT	UG/L	2	.00	.00	.00	.00	74/08/27	75/05/12
DISS SOL	SUM	MG/L	37	224.0	3920.0	303.0	10.0	74/08/20	75/07/08
ELEV	LND SJRF	FT	1	6850.0		6850.0	6850.0	74/08/20	74/08/20
SUSP SED	CONC	MG/L	37	15.8	357.0	32.0	.0	74/08/20	75/07/08

Table 22. Chemical and physical statistics of Angus Creek, 1/2 mile above Caribou National Forest boundary (Kelly).

PARAMETER			NUMBER	MEAN	VARIANCE	MAXIMUM	MINIMUM	BEG DATE	END DATE
WATER	TEMP	FAHN	35	41.9	78.0	57.0	32.0	74/08/13	75/07/09
AIR	TEMP	FAHN	35	45.4	317.0	75.0	9.0	74/08/13	75/07/09
CLOUD	COVER	PERCENT	36	43.0	1856.0	100.0	.0	74/08/13	75/07/09
STREAM	FLOW	INST-CFS	14	2.68	4.29	3.41	1.20	74/08/13	75/06/16
STREAM	STAGE	FEET	36	.80	.16	2.57	.55	74/08/13	75/07/09
TURB	TRBIDMTR	HACH FTU	35	2.50	5.32	9.40	.48	74/08/19	75/07/09
CNDUCTVY	AT 25C	MICROMHO	35	303.0	1319.5	333.0	184.0	74/08/19	75/07/09
PH		SU	15	7.7	.6	8.7	6.5	74/10/17	75/06/04
LAB	PH	SU	3	8.2	.01	8.3	8.1	75/06/24	75/07/09
T ALK	CACO3	MG/L	35	160.0	1122.0	194.0	58.0	74/08/19	75/07/09
NO2-N	TOTAL	MG/L	21	.058	.048	1.01	.000	75/02/25	75/07/09
NO3-N	TOTAL	MG/L	21	.143	.001	.220	.050	75/02/25	75/07/09
TOT KJEL	N	MG/L	35	1.89	.472	3.30	.860	74/08/19	75/07/09
PHOS-TOT		MG/L P	33	.131	.005	.455	.059	74/08/19	75/06/24
PHOS-DIS		MG/L P	20	5.07	499.0	100.0	.04	75/03/18	75/07/09
TOT HARD	CACO3	MG/L	35	158.0	785.0	198.0	64.0	74/08/19	75/07/09
ARSENIC	AS,TOT	UG/L	2	.00	.00	.00	.00	74/08/27	75/05/12
CADMIUM	CD,TOT	UG/L	2	.00	.00	.00	.00	74/08/27	75/05/12
CHROMIUM	CR,TOT	UG/L	2	3.0	2.0	4.0	2.0	74/08/27	75/05/12
COPPER	CU,TOT	UG/L	2	6.5	4.5	8.0	5.0	74/08/27	75/05/12
VANADIUM	V,TOT	UG/L	2	13.0	338.0	26.0	.00	74/08/27	75/05/12
ZINC	ZN,TOT	UG/L	2	11.4	147.0	20.0	2.80	74/08/27	75/05/12
SELENIUM	SE,TOT	UG/L	2	.00	.00	.00	.00	74/08/27	75/05/12
DISS SOL	SUM	MG/L	35	203.00	728.0	230.0	120.0	74/08/19	75/07/09
ELEV	LND SURF	FT	1	6625.0		6625.0	6625.0	74/08/13	74/08/13
SUSP SED	CONC	MG/L	35	12.3	290.0	85.0	.0	74/08/19	75/07/09

Table 23. Chemical and physical statistics of the Blackfoot River, immediately downstream from the boundary of the Caribou National Forest (Kelly).

PARAMETER			NUMBER	MEAN	VARIANCE	MAXIMUM	MINIMUM	BEG DATE	END DATE
WATER	TEMP	FAHN	39	43.6	51.7	58.0	33.0	74/08/20	75/07/08
AIR	TEMP	FAHN	39	47.9	241.0	81.0	15.0	74/08/20	75/07/08
CLOUD	COVER	PERCENT	40	52.0	1750.0	100.0	.0	74/08/20	75/07/08
STREAM	FLOW	INST-CFS	33	241.0	88567.0	1172.0	78.0	74/08/20	75/06/16
STREAM	STAGE	FEET	40	1.66	1.30	4.70	.800	74/08/20	75/07/08
TURB	TRBIOMTR	HACH FTU	40	5.80	135.0	78.0	.45	74/08/20	75/07/08
CNDUCTVY	AT 25C	MICROMHO	40	377.0	13233.0	942.0	281.0	74/08/20	75/07/08
PH		SU	22	7.5	.7	8.8	6.5	74/10/10	75/06/04
LAB	PH	SU	3	8.1	.005	8.2	8.0	75/04/24	75/07/08
T ALK	CACO3	MG/L	40	190.0	16629.0	960.0	82.0	74/08/20	75/07/08
NO2-N	TOTAL	MG/L	26	.000	.000	.010	.000	75/02/25	75/07/08
NO3-N	TOTAL	MG/L	26	.131	.006	.270	.040	75/02/25	75/07/08
TOT KJEL	N	MG/L	40	2.23	5.86	15.80	.90	74/08/20	75/07/08
PHOS-TOT		MG/L P	38	.106	.005	.293	.003	74/08/20	75/06/24
PHOS-DIS		MG/L P	25	.112	.018	.750	.040	75/03/18	75/07/08
TOT HARD	CACO3	MG/L	40	181.0	1522.0	310.0	98.0	74/08/20	75/07/08
ARSENIC	AS,TOT	UG/L	2	.00	.00	.00	.00	74/08/26	75/05/13
CADMIUM	CD,TOT	UG/L	2	.00	.00	.00	.00	74/08/26	75/05/13
CHROMIUM	CR,TOT	UG/L	2	3.70	10.5	6.00	1.40	74/08/26	75/05/13
COPPER	CU,TOT	UG/L	2	6.45	12.0	8.90	4.00	74/08/26	75/05/13
VANADIUM	V,TOT	UG/L	2	15.0	450.0	30.0	.00	74/08/26	75/05/13
ZINC	ZN,TOT	UG/L	2	3.50	4.50	5.00	2.00	74/08/26	75/05/13
SELENIUM	SE,TOT	UG/L	2	.00	.00	.00	.00	74/08/26	75/05/13
DISS SOL	SUM	MG/L	40	252.0	6348.0	550.0	183.0	74/08/20	75/07/08
ELEV	LND SJRF	FT	1	6388.0		6388.0	6388.0	74/08/20	74/08/20
SUSP SED	CONC	MG/L	40	29.5	1088.0	141.0	.0	74/08/20	75/07/08

Table 24. Chemical and physical statistics of Kendall Creek, 100 yards below the Caribou National Forest boundary (Kelly).

PARAMETER			NUMBER	MEAN	VARIANCE	MAXIMUM	MINIMUM	BEG DATE ,	END DATE
WATER	TEMP	FAHN	21	39.1	11.4	45.0	32.0	74/10/22	75/06/25
AIR	TEMP	FAHN	21	35.5	77.2	58.0	12.0	74/10/22	75/06/25
CLOUD	COVER	PERCENT	22	76.0	1545.0	100.0	.0	74/10/22	75/06/25
TURB	TRBIDMTR	HACH FTU	22	.88	.71	4.20	.22	74/10/22	75/06/25
CNDUCTVY	AT 25C	MICROMHO	22	290.0	4421.0	345.0	.3	74/10/22	75/06/25
PH		SU	13	7.9	.5	8.8	6.9	75/10/20	75/06/03
LAB	PH	SU	1	8.3		8.3	8.3	75/06/25	75/06/25
T ALK	CACO3	MG/L	22	162.0	63.0	175.0	146.0	74/10/22	75/06/25
NO2-N	TOTAL	MG/L	17	.008	.0002	.050	.000	75/02/24	75/06/25
NO3-N	TOTAL	MG/L	17	.144	.001	.200	.050	75/02/24	75/06/25
TOT KJEL	N	MG/L	22	1.95	.25	2.00	.80	74/10/22	75/06/25
PHOS-TOT		MG/L P	22	.118	.019	.712	.035	74/10/22	75/06/25
PHOS-DIS		MG/L P	17	.060	.0004	.098	.016	75/02/24	75/06/25
TOT HARD	CACO3	MG/L	22	166.0	95.0	192.00	154.0	74/10/22	75/06/25
ARSENIC	AS,TOT	UG/L	1	.00		.00	.00	75/05/14	75/05/14
CADMIUM	CD,TOT	UG/L	1	.00		.00	.00	75/05/14	75/05/14
CHROMIUM	CR,TOT	UG/L	1	2.0		2.0	2.00	75/05/14	75/05/14
COPPER	CU,TOT	UG/L	1	3.0		3.0	3.0	75/05/14	75/05/14
VANADIUM	V,TOT	UG/L	1	.00		.00	.00	75/05/14	75/05/14
ZINC	ZN,TOT	UG/L	1	12.0		12.0	12.0	75/05/14	75/05/14
SELENIUM	SE,TOT	UG/L	1	.00		.00	.00	75/05/14	75/05/14
DISS SOL	SUM	MG/L	22	201.0	42.0	225.0	190.0	74/10/22	75/06/25
SUSP SED	CONC	MG/L	22	13.0	184.0	59.0	.00	74/10/22	75/06/25

Table 25. Chemical and physical statistics of Mill Creek, 100 yards upstream from the Caribou National Forest boundary (Kelly).

PARAMETER			NUMBER	MEAN	VARIANCE	MAXIMUM	MINIMUM	BEG DATE	END DATE
WATER	TEMP	FAHN	38	43.6	15.6	54.0	37.0	74/08/13	75/07/09
AIR	TEMP	FAHN	39	42.4	195.4	75.0	10.0	74/08/13	75/07/09
CLOUD	COVER	PERCENT	40	55.0	2230.0	100.0	0	74/08/13	75/07/09
STREAM	FLOW	INST-CFS	29	2.99	.38	4.45	1.90	74/08/13	75/07/01
STREAM	STAGE	FEET	40	.957	.028	1.48	.780	74/08/13	75/07/09
TURB	TRBIDMTR	HACH FTU	38	.95	.42	2.70	.25	74/08/19	75/07/09
CNDUCTVY	AT 25C	MICROMHO	38	315.0	105.0	345.0	300.0	74/08/19	75/07/09
PH		SU	19	7.7	.5	8.8	6.8	74/10/17	75/06/05
LAB	PH	SU	3	8.2	.0	8.4	8.0	75/06/25	75/07/09
T ALK	CACO3	MG/L	38	173.0	110.0	190.0	150.0	74/08/19	75/07/09
NO2-N	TOTAL	MG/L	24	.000	.000	.010	.000	75/02/24	75/07/09
NO3-N	TOTAL	MG/L	24	.161	.001	.250	.100	75/02/24	75/07/09
TOT KJEL	N	MG/L	38	2.02	.364	3.80	.600	74/08/19	75/07/09
PHOS-TOT		MG/L P	36	.204	.028	.884	.050	74/08/19	75/06/25
PHOS-DIS		MG/L P	23	.114	.002	.200	.000	75/03/17	75/07/09
TOT HARD	CACO3	MG/L	38	170.0	57.0	185.0	154.0	74/08/19	75/07/09
ARSENIC	AS,TOT	UG/L	2	.00	.00	.00	.00	74/08/26	75/05/14
CADMIUM	CD,TOT	UG/L	2	.00	.00	.00	.00	74/08/26	75/05/14
CHROMIUM	CR,TOT	UG/L	2	10.15	29.64	14.00	6.30	74/08/26	75/05/14
COPPER	CU,TOT	UG/L	2	3.30	.180	3.60	3.00	74/08/24	75/05/14
VANADIUM	V,TOT	UG/L	2	17.5	612.5	35.0	.0	74/08/26	75/05/14
ZINC	ZN,TOT	UG/L	2	13.25	231.12	24.00	2.50	74/08/26	75/05/14
SELENIUM	SE,TOT	UG/L	2	.00	.00	.00	.00	74/08/26	75/05/14
DISS SOL	SUM	MG/L	38	210.0	65.0	225.0	195.0	74/08/19	75/07/09
ELEV	LND SURF	FT	1	6550.0		6550.0	6550.0	74/08/13	74/08/13
SUSP SED	CONC	MG/L	38	8.73	65.94	35.0	.00	74/08/13	75/07/09

Table 26. Generalized chemical and physical statistics of the upper Blackfoot River area, compiled from statistics of 8 streams - Angus Creek, Blackfoot River, Diamond Creek, Kendall Creek, Mabie Creek, Mill Creek, Sheep Creek, and Stewart Creek (Kelly).

PARAMETER			NUMBER	MEAN	VARIANCE	MAXIMUM	MINIMUM	BEG DATE	END DATE
WATER	TEMP	FAHN	300	41.4	46.3	55.0	32.0	74/08/13	75/07/09
AIR	TEMP	CAHN	334	43.5	221.4	85.0	.5+1	74/08/13	75/07/09
CLOUD	COVER	PERCENT	345	52.0	1878.0	100.0	0	74/08/13	75/07/09
STREAM	FLOW	INST-CFS	160	53.3	27089.6	1172.0	.0	74/08/02	75/07/02
STREAM	STAGE	FEET	287	.92	.67	4.70	.00	74/08/02	75/07/09
TURB	TRBIDMTR	HACH FTU	307	5.0	359.3	300.0	.2	74/08/19	75/07/09
CNDUCTVY	AT 25C	MICROMHO	306	330.0	6652.0	1015.0	.3	74/08/19	75/07/09
PH		SU	147	7.5	.5	8.9	6.4	74/10/10	75/06/05
LAB	PH	SU	27	8.2	.01	8.4	7.9	75/06/24	75/07/09
T ALK	CACO3	MG/L	306	173.0	3154.0	950.0	6.0	74/08/19	75/07/09
NO2-N	TOTAL	MG/L	202	.017	.005	1.01	.000	75/02/24	75/07/09
NO3-N	TOTAL	MG/L	202	.181	.011	.800	.040	75/02/24	75/07/09
TOT KJEL	N	MG/L	306	2.27	2.93	21.00	.10	74/08/19	75/07/09
PHOS-TOT		MG/L P	290	.165	.043	2.35	.001	74/08/19	75/06/25
PHOS-DIS		MG/L P	196	.63	50.91	100.00	.00	75/02/24	75/07/09
TOT HARD	CACO3	MG/L	306	172.0	967.0	325.0	8.0	74/08/19	75/07/09
ARSENIC	AS,TOT	UG/L	17	.00	.00	.00	.00	74/08/26	75/05/28
CADMIUM	CD,TOT	UG/L	17	.00	.00	.00	.00	74/08/26	75/05/28
CHROMIUM	CR,TOT	UG/L	17	4.66	15.35	14.00	1.00	74/08/26	75/05/28
COPPER	CU,TOT	UG/L	17	5.08	3.75	8.90	2.0	74/08/26	75/05/28
VANADIUM	V,TOT	UG/L	17	11.88	185.98	35.00	.00	74/08/26	75/05/28
ZINC	ZN,TOT	UG/L	17	12.44	278.80	57.50	1.50	74/08/26	75/05/28
SELENIUM	SE,TOT	UG/L	17	.58	5.88	10.00	.00	74/08/26	75/05/28
DISS SOL	SUM	MG/L	306	221.0	3066.0	700.0	10.0	74/08/19	75/07/09
ELEV	LND SJRF	FT	8	6689.0	39862.0	6925.0	5388.0	74/08/02	74/08/20
SUSP SED	CONC	MG/L	306	151.0	1525004	19740.0	0	74/08/19	75/07/09

Water Temperatures

The average temperature of the Blackfoot River, Angus Creek and Mill Creek are similar to the average water temperature of the area (41 degrees F), and are within tolerance levels for trout, while the average temperature of Kendall Creek is low. The temperature maximums are satisfactory in all cases except on Kendall Creek, where 45 degrees F is fairly low, and on Angus Creek, headwaters, where 66 degrees F is high. The recorded high water temperature on Angus Creek (66° F), (7/8/75), is the only suggestion of any thermal problems in the area. The differentials between the standard deviations of air and water temperatures indicate that the water temperature levels are not completely dominated by the climate, and streams are receiving some insulation or influence by subsurface recharge.

Specific Electrical Conductance

The water conductance in all four streams is favorable and indicates no excessive amounts of ionized materials. However, the Blackfoot River (maximum conductance of 942 micromhos) occasionally exceeded the desirable level, but not the critical level. Angus Creek, at the headwaters, significantly exceeded a maximum conductance of 439 micromhos and was the highest norm for the area over the entire winter (1/10/74 to 4/30/75). This excess conductance could suggest that subsurface waters someplace before their form of precipitation and prior to streamflow has contact with materials more easily dissolved than in other watersheds.

Hydrogen Ion Concentration

The hydrogen ion concentration is moderately alkaline (7.6) which favors aquatic growth and trout production. This general appraisal applies to the Blackfoot River, Kendall Creek, Mill Creek and lower Angus Creek. In the upper Angus, headwater, pH is closer to the neutral state (7.1).

Hardness and Alkalinity

The upper Blackfoot River water is hard (172 mg/l) and alkaline (173 mg/l), and this high hardness characteristic also applies to the Kendall Creek, Mill Creek and lower Angus Creek. Upper Angus Creek water is also hard with the exception of one sample on 22 of January 1975, which indicated a hardness of 8 mg/l and an alkalinity of 6 mg/l. This one sample is probably a laboratory analysis error.

Turbidity, Dissolved Solids and Suspended Sediment

The normal low turbidity of the general area (5.1 FTU) in the upper Blackfoot River, Angus Creek, Kendall Creek and Mill Creek indicate very low norms of those dissolved solids and suspended sediment capable of interference with light transmission or aquatic respiration. Some streams such as Maby Creek (14 FTU), within the general area, however, occasional load with suspended and dissolved solids. Angus Creek, headwater section, during the fall of 1974 carried high amounts of dissolved solids, and on 18 March 1975 had high concentrations of dissolved solids (650 mg/l), and on 30 April and 15 May 1975 exceeded levels of suspended solids that are favorable to aquatic life. These instances are exceptions.

Phosphate and Nitrogen

The total phosphates on all streams of study area, except Angus Creek, headwaters, and Mill Creek, are at levels that are adequate, but not excessive, for allowing nutrients to expand into a favorable aquatic biomass. On Angus Creek, headwaters, and Mill Creek the total phosphates are high enough to encourage over-eutrophication if nitrates are not limiting. The highest nitrate concentration also occurred in the headwaters of Angus Creek, as well as one of the highest concentrations of nitrates. The lower Angus Creek station also had high nitrite ^{nitrite} levels which suggests, but do not establish, an unfavorable water state.

Metals

Analyses for concentrations of metals (arsenic, cadmium, chromium, copper, selenium, vanadium, and zinc) disclosed that in all streams heavy metal concentrations were very low. No heavy metal problems exist.

SUMMARY

Current and future proposed mining warrant the continuation of studies of the aquatic environments and fisheries in all streams in the mine influence areas. The potential for aquatic damages is high unless land managers have the information necessary to make their decisions. This information is not available at this time.

The structure of the upper Blackfoot River and its tributaries is a high mountain drainage with the necessary conditions to sustain a good sport fisheries. A study of the hydrochemistry and hydrophysics of these streams from 1970 to 1974, however, revealed some possible limiting factors. Iron at certain periods may be higher than normal, and water temperatures are not always optimum for cutthroat trout. Specific for Angus Creek and Mill Creek is a statistically significant, higher chemical oxygen demand, which is suggestive of septicity.

Macroinvertebrate analysis was used to assay biologically for the presence of pollutants. Shaw and Newell (1974) and Pace (1975) identified the macroinvertebrates inhabiting the streams and interpreted their presence and diversity. High velocity water forms were present in Kendall Creek, Mill Creek, the Blackfoot River and the middle and lower reaches of Angus Creek, whereas low velocity water forms inhabited the headwater region of Angus Creek. Also found was the fact that ranges of discrete taxa in three orders of insects which are highly sensitive to organic pollutants were more in accord with the ranges of discrete taxa in known-unpolluted streams than with the ranges in known-polluted

streams. Three other indications of the macroinvertebrate analysis that demonstrates the upper Blackfoot River and Angus, Kendall and Mill Creeks are not polluted are (1) that the taxa found in the study streams were not characteristic of polluted waters; (2) that polluted streams would not have such a large number of diverse taxa as that found in the study stream; and (3) that the diversity index for the upper Blackfoot River and its tributaries falls within a range characteristic of clean or recovered streams. The sampling of fish populations showed that the macroinvertebrate analysis above cannot be used by itself as a biotic indicator, since areas having high macroinvertebrate species diversity simultaneously are dominated by undesirable fish species.

Sampling of fish populations in Angus Creek during the years 1971-74 evidenced the presence of large numbers of cutthroat trout (young and adults), these trout being confined more to the upper reaches but present throughout the stream. In the lower reaches non-game species of dace, shiners, suckers and sculpins increased in number and dominated the aquatic habitat. Cutthroat trout collected in the Blackfoot River in 1973 had twice the size above the confluence of Angus Creek as below the confluence.

Chemical and physical monitoring of the entire general area enlarged the number of known parameters, increased the reliability of those previously established, and disclosed changes in these parameters. Analysis of the data provided by the monitoring also indicated some potential problem areas. A stream section consistently indicated as a potential problem is the headwater region of Angus Creek. This area recorded higher water temperatures, a specific electrical conductance

that exceeded all other norms over an entire winter, an abnormal lowering of pH, an unusually low exception to hardness and alkalinity levels, high amounts of dissolved solids, suspended sediment, phosphates, nitrates and nitrites. Analysis for metals demonstrated no limiting effects.

CONCLUSIONS

The five years of periodic study of the upper Blackfoot River and three of its tributaries - Angus, Kendall and Mill Creeks - lead to the conclusion that the upper Blackfoot River system offers conditions favorable for an extensive sport fishery. The streams are valuable not only as producers of resident cutthroat trout but also function as spawning and nursery areas for migratory cutthroat trout. This value however, is dependent upon delicate relationships. Disturbance of these delicate relationships could disrupt the current sport fishery.

To a minor degree, the data indicate that the upper region of Angus Creek is naturally different, or could have been disturbed by some past or current activity, because of:

1. High COD.
2. High total organic carbon.
3. An instance of high water temperature.
4. High specific electrical conductance.
5. A lowering of the pH.
6. A low exception to hardness and alkalinity.
7. High amounts of dissolved solids and suspended sediment.
8. High concentrations of phosphates, nitrates and nitrites.
9. Low water velocity forms of macroinvertebrates.
10. Establishment of cutthroat competitors in the lower reaches.

While it appears conditions have not reduced cutthroat trout spawning and rearing in upper Angus Creek, conditions do encourage the domination of salmonid competitors in the lower reaches and in some sections to the almost total exclusion of cutthroat trout.

RECOMMENDATIONS

The cutthroat trout habitat in the upper Blackfoot River system needs additional protection, as it is in a delicate state. To further protect spatial and temporal conditions in the Blackfoot system, the following should be implemented:

1. Aquatic environment and fisheries studies in the four study streams should be continued, in order to detect any further change in the aquatic environment.
2. All aquatic environments and their fish populations in all existing or proposed phosphate mine-influenced areas should be documented before environmental intrusions.
3. Studies should be initiated to determine the validity in predicting effects on the aquatic environment and fisheries from different mining activities; expansion of mining, human population increase, increase in recreational demands, land development for urban or commercial use, additional water diversions, and increased fishing pressure.

METHODS AND EQUIPMENT

Aquatic Structure and Streamside Environment

The methods and techniques used for determining the condition of and changes within the aquatic environment follow set procedures used in other studies (Platts, 1975).

Stations

Stations to determine stream condition were determined randomly and marked on an aerial photograph. The station was then found on the ground with the use of the photograph and staked for permanent recognition. Most stations contained 5 transects, but some monitoring areas contained the number of transects needed to cover the area. Monitoring stations, used to determine temporal conditions, were individually selected to fit the requirements for monitoring a certain area or a land use activity. All stations are recorded and the record filed in ranger district office files.

Transects

At each of the study stations (excluding monitoring stations) five stream transects, located 50 feet apart, were eventually marked with steel or wooden stakes. Each stake was numbered. In the beginning of the study many transects were not marked, because money was not available to purchase stakes. Monitoring stations included the number of transects needed for the type of documentation. By 1974 all of the monitoring transects had been permanently marked. Transects were

located from bank to bank at a 90 degree angle to the centerline flow of the stream. The following measurements or condition factors were recorded:

1. Pool and riffle width and rating

The stream was stratified as to pool and riffle. The pools in turn were classified as to suitability to fish environment based on the criteria outlined in Table 27. Riffle and pool areas were measured to the nearest foot, the sum of the two equaling the stream width.

2. Average stream depth and width

Stream width was measured from water's edge or one bank to the opposite water's edge on the other bank, perpendicular with the streamflow. Stream depth was averaged from four measurements equally spaced along the transect beginning at waters edge (0 inches), and continuing for three additional 0.25 intervals across the transect.

3. Streambed surface material

The streambed material composition was determined by direct measurement. The streambed transect was partitioned into one-foot intervals, and these intervals classified by the dominant surface material. For example, if within a one-foot interval there were 8" of fine sediment, 2" of gravel and 2" of rubble, the one-foot area would be completely classified as fine sediment. On each transect the streambed surface material was measured and classified

Table 27. Pool quality rating guide.

Quality Class No.	Length or Width	Depth - 1974 1970-74 in Parenthesis	Shelter ¹
1	Greater than a.c.w. ² Greater than a.c.w.	(1') 2' or deeper (2') 3' or deeper	Abundant ³ Exposed ⁴
2	Greater than a.c.w. Greater than a.c.w. Greater than a.c.w.	(1') 2' or deeper (1') 2' (1') 2'	Exposed Intermediate Abundant
3	Equal to a.c.w. Equal to a.c.w.	(1') 2' (1') 2'	Intermediate Abundant
4	Equal to a.c.w. Less than a.c.w. Less than a.c.w. Less than a.c.w. Less than a.c.w.	Shallow ⁶ Shallow Shallow (1') 2' (1') 2' or deeper	Exposed Abundant Intermediate Intermediate Abundant
5	Less than a.c.w.	Shallow	Exposed

1. Logs, stumps, boulders, and vegetation in or overhanging pool, or overhanging banks.

2. a.c.w. = Average channel width.

3. More than 1/2 perimeter of pool has cover.

4. Less than 1/4 of pool perimeter has cover.

5. 1/4 to 1/2 perimeter of pool has cover.

6. Approximately equal to average stream depth.

in accord with the following guidelines:

- a. Boulder: 12 inches, or over, in particle diameter.
 - b. Rubble: 3 to 11.9 inches in particle diameter.
 - c. Gravel: 0.19 to 2.9 inches in particle diameter.
 - d. Fines: less than 0.19 inches in particle diameter.
4. Streambank cover, stability and type

Streambank cover was rated as forested (4), brush (3), grass (2) and exposed (1). The cover rating was determined by evaluating the dominant vegetative type, or lack of vegetation, within an area of 50 feet upstream and 50 feet downstream from the transect point. Streambank stability was rated at both ends of each transect as excellent (4), good (3), fair (2), and poor (1). Streambank type, the habitat character of the streambank that intersects the transect, was rated as shown in Table 28.

Hydrochemical and Hydrophysical Sampling

Water samples were collected in inert plastic bottles, the bottles having previously been thoroughly steamed, washed and rinsed in hot distilled water. Prior to sample collection, each bottle was stripped twice with spectrometric grade nitric acid. The acid rinse was left in the bottles after the second stripping, and the bottle was capped. The acid remaining was sufficient to buffer the sample that would be analyzed for heavy metals.

Table 28. System of coding used to classify streambank cover, stability, and type.

<u>Cover</u>	<u>Stability</u>	<u>Type</u>	
Forested 4	Excellent 4	Sand or Soil	
Brush 3	Good 3	Soil (Gravel)*	1
Grass 2	Fair 2	Sand (Gravel)	
		Soil (Rubble, Boulder, Log, Sod or Tree)	
		Sand (Rubble, Boulder, Log, Sod or Tree)	2
		Gravel	
		Gravel (Sand or Rubble)	
		Debris	
		Gravel (Boulder, Log, Sod, or Tree)	
		Rubble	3
		Rubble (Sand or Gravel)	
		Rubble (Boulder, Log, Sod or Tree)	
		Boulder (Sand)	
		Log (Soil or Sand)	4
		Moss (Soil or Sand)	
		Sod (Soil or Sand)	
		Root (Soil or Sand)	
		Brush (Sand)	
		Boulder (Gravel)	
		Log (Gravel or Rubble)	
		Root (Gravel or Rubble)	
		Sod (Gravel or Rubble)	5
		Sod (Moss, Log or Root)	
		Brush (Gravel or Rubble)	
		Boulder (Rubble or Brush)	
		Log (Boulder)	
		Root (Boulder)	6
		Sod (Boulder, Log or Root)	
		Brush (Boulder, Sod or Tree)	7
		Sod (Tree)	
		Brush	
		Boulder	8
		Tree	
		Bedrock	

*Parenthesis denotes subordinate streambank type or second most predominate feature in the streambank type in rating hierarchically.

At each station two samples were collected. The first bottle (4 oz) was filled in a riffle area in midstream. The bottle was capped after the first filling, this sample being used for heavy metal analysis in a medium acidified by the remaining nitric acid from the second stripping. The second bottle (16 oz) was filled in the same manner, with the exception that it was shaken and emptied three times, the fourth filling being retained.

All samples were frozen during the day of collection and retained in the frozen state until analyzed by the Idaho Department of Health and Welfare laboratory. The analysis was performed within the guidelines outlined in the Standard Methods (1971). Dissolved gasses and pH were done in the field with Hach equipment.

Benthic Macroinvertebrate Enumeration (Shaw & Newell, 1974, Pace, 1975)

Benthic macroinvertebrates were collected by Forest Service personnel at ten study stations on the upper Blackfoot River, Angus Creek, Kendall Creek and Mill Creek during September, October and November of 1973 and during August, September and October of 1974: four stations (1A, M2, M3 and M4) were on Angus Creek, two (MB1 and MB2) were on the Blackfoot River, two stations (M5 and M6) on Mill Creek and two (K1 and K2) on Kendall Creek. To provide a consistent sampling method, artificial substratum samplers were used at each station. The samplers, measuring 8"x8"x3" (0.11 ft^3) were hardware baskets, filled with slag or rubble and gravel from the stream bottom. Three samplers were positioned at each station on the stream bottom and made available for colonization by invertebrates for a period of 30 to 35 days. At the end of this period the samplers were removed from the stream. All invertebrates and

detritus were retained and concentrated by rinsing through a 0.42 mm screen. The samples were placed in plastic or glass containers, labeled, preserved in 70% ethanol alcohol, and transferred to Idaho State University for processing.

The processing procedure consisted of sorting, identifying and counting the macroinvertebrates after isolating them from the detrital material. This included rinsing and sorting all samples through a series of U. S. Standard sieves with openings of 6.73 mm, 3.36 mm and 0.35 mm. If a small amount of material remained in the 0.35 mm sieve, the sample was not split into subsample fractions. If, however, a large quantity of material remained, the sample was further divided. A subsampling device designed by Waters (1969) was used to portion the remnant into eighths, 1/8 to 3/8 being retained for further processing and termed the Subsample Fraction (SF). The parts of the sample collected in the 6.73 mm and 3.36 mm sieves were designated the Coarse Fractions (CF), but were processed identically with the Subsample Fraction from this step of the procedure.

In small portions the samples were scanned with a Luxo Magnifier Lamp, which has a magnification of 3 diopters, the organisms being extracted and stored in a medium of 10% Formalin until they were identified to the lowest taxa and counted. For identification keys by Gaufin (1966) Pennak (1953), Usinger (1956) and Ward and Whipple (1959) were used. In the subsamples the number of invertebrates in each taxon was multiplied by the reciprocal of the subsample fraction.

The method developed by Shannon and Weaver (1964) was used to calculate the mean species diversity indices. Equitability was computed according to Lloyd and Ghelardi (1964), and redundancy according to Wilhm and Dorris (1968).

Fish Collection and Examination

Nine permanent rectangular stations, with stakes demarcating the corner limits, were positioned in different stream locations for sampling fish populations with electro-fish collection equipment. Fish collected were identified by species, and the total length of each individual was recorded.

Monitoring - Chemical and Physical

Samples were collected under the direction of the U. S. Forest Service hydrologist, Pocatello, Idaho, commencing on these dates:

Angus Creek, headwaters	- 20 August 1974
Angus Creek, 1/2 mi abv NF By	- 19 August 1974
Blackfoot River	- 20 August 1974
Kendall Creek	- 22 October 1974
Mill Creek	- 13 August 1974

Temperatures, discharges and pH levels were read in the field, while all the other data were results of laboratory chemical and physical analyses made in accord with approved EPA methods. After collection, the statistical analysis of the data was computerized at the Washington Data Center, Rockville, MD. The remainder of the plan for sample collection varied by season.

LITERATURE CITED

American Public Health Association.

1971. Standard methods for the examination of water and wastewater. 13th ed. 974 p. Washington, D. C.

Columbia Basin Inter-Agency Committee.

1965. River mile index - Snake River. A report of the Hydrology Subcommittee. 96 p.

Doudoroff, P. and M. Katz.

1953. Critical review of literature on the toxicity of industrial wastes and their components to fish II. The metals, as salts. Sewage and Industrial Wastes. 25:802.

Gaufin, A. R., A. V. Nebeker and J. Sessions.

1966. The stoneflies (Plecoptera) of Utah. 93 p. University of Utah Press. Salt Lake City.

Gaufin, A. R. and C. M. Tarzwell.

1952. Aquatic invertebrates as indicators of stream pollution. 67:5764. U. S. Public Health Report.

Gaufin, A. R. and C. M. Tarzwell.

1956. Aquatic macroinvertebrate communities as indicators of organic pollution in Lytle Creek. Sewage and Industrial Wastes. 28:906-924.

Heimer, John T.

1972. Blackfoot fisheries inventory. 15 p. Idaho Fish and Game Department.

Idaho Water Resource Board.

1972. Interim state water plan - preliminary report. 265 p. State of Idaho, Boise, Idaho.

Kelly, Dennis.

- 1975(a). Monitoring physical and chemical samples in Mill Creek. 12 p. Washington Data Center, Rockville, MD.

Kelly, Dennis.

- 1975(b). Monitoring physical and chemical samples in the upper Blackfoot River. 12 p. Washington Data Center, Rockville, MD.

Lloyd, M. and R. J. Ghelardi.

1964. A table for calculating the "equitability" component of species diversity. Journal of Animal Ecology. 33:217-225.

Pace, Ronald K.

1975. A comparison of the composition and diversity of the benthic macroinvertebrates of the upper Blackfoot River and three tributaries: Angus Creek, Kendall Creek, and Mill Creek for 1973 and 1974. 83 p. Unpublished. U.S.F.S. - R-4.

Pacific Northwest River Basin Commission.

1970. Water resources. Comprehensive framework study of water and related lands. Vol I. 543 p.

Parsons, J. D.

1968. The effects of acid strip-mine effluents on the ecology of a stream. Arch. Hydrobiol. 65:25-50.

Pennak, R. W.

1953. Fresh-water invertebrates of the United States. 769 p. The Ronald Press Co., New York.

Platts, William S.

1970. Angus Creek proposed aquatic habitat study. 5 p. Unpublished. U. S. Forest Service, Region 4.

Platts, William S.

1970a. Aquatic habitat studies in the Angus Creek drainage. Progress Report 1. 5 p. Unpublished. U.S. Forest Service, Region 4.

Platts, William S.

1973. Aquatic habitat studies in the Angus Creek drainage. Progress Report 2. 11 p. Unpublished. U.S. Forest Service, Region 4.

Platts, William S.

1973a. Aquatic environment studies in the Angus Creek drainage. Progress Report 3. 7 p. Unpublished. U.S. Forest Service, Region 4.

Platts, William S.

1975. Preliminary aquatic environment and fisheries information for input into the regional phosphate planning unit. 160 p. Unpublished. U.S. Forest Service, Region 4.

Shannon, C. E. and W. Weaver.

1964. The mathematical theory of communication. 125 p. University of Illinois Press, Urbana.

Shaw, David W. and Robert L. Newell

1974. Composition and diversity of the benthic macroinvertebrates of the upper Blackfoot River and three tributaries: Angus Creek, Kendall Creek, and mill Creek. 99 p. Unpublished. U.S. Forest Service, Region 4.

Usinger, R. L.

1956. Aquatic insects of California. 508 p. University of California Press. Berkeley and Los Angeles.

U. S. Geological Survey.

1965. Water resources data for Idaho. 327 p. A publication of the U. S. Department of the Interior, Geological Survey - Water Resources Div.

Ward, H. B. and G. C. Whipple.

1959. Fresh-water biology. 1248 p. John Wiley & Sons, New York.

Waters, T. F.

1969. Subsampler for dividing large samples of stream invertebrate drift. Limnology and Oceanography. 14:813-815.

Wilhm, J. L

1970. Range of diversity index in benthic macroinvertebrate populations. J. Water Pollut. Control Fed. 42:R221-R224.

Wilhm, J. L. and T. C. Dorris.

1966. Species diversity of benthic macroinvertebrates in a stream receiving domestic and oil refinery effluents. Am. Mid. Water. 76:427-449.